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First Day, May 9th, 1916

OBSTRUCTIVE CALCULOUS PROSTATE

By William Warren Townsend, M.D., of Rutland, Vt.

FROM personal experience with three cases of calculous prostate causing urinary obstruction and from a study of the cases to be found in the literature, I believe that this condition is one which occurs more frequently—the pathology comprising prostatism with a varying amount of residuum, produced by partial or complete obstruction—than is generally appreciated. I believe that many of us massage and otherwise treat prostates for chronic prostatitis with and without success; those that do not come to a successful termination may possibly not have received benefit owing to the presence of calcareous deposits within the parenchyma of the gland, which destroy tissue and which are replaced by fibrous substance that contracts and distorts the contour of the internal urethral meatus, producing obstruction.

The type of case which I offer for discussion is not to be confounded with the condition described as "secondary prostatic calculus," in which a renal or vesical calculus becomes lodged in the prostatic urethra, wherein a constant deposit upon it of urinary salts changes it from a small calculus to

one of considerable size, which oftentimes juts into the bladder and is usually palpable by rectal examination.

The total number of cases of calculous degeneration of the prostate reported to date must be considerably over 50. In 1914, Glaesel [1] was able to find notes of 54, and this list does not include others collected by V. C. Pedersen [2] one year earlier. In studying these cases, one finds it somewhat difficult to select those with total and permanent obstruction. Many with a history of severe urethral stricture have to be rejected, while in others we find histories of temporary or subtotal obstruction. It seems safe to assert that at least 10 cases may be selected as examples of virtually complete obstruction.

The first of these cases was published in 1834 by Lartet [3] and was practically an autopsy case, as patient was under observation but a few days, during which time it was impossible to catheterize him. The gland contained a number of faceted stones. There is no mention of stricture. The organ was said to be gangrenous and there was also a black area in the bladder.

We find no other cases until 1867, when Manzoni [4] reported one admitted for complete urinary retention. It is said that a correct pre-operative diagnosis was made. Intrarectal prostatotomy was followed by the difficult extraction of a stone, but a permanent fistula remained. The patient was only 35 years old. Robin,[5] in 1873, reported a case, aged 70, in whom complete retention followed a debauch. Relief was obtained by puncture, but death resulted in a few days. There was typical hypertrophy of the prostate and the presence of a considerable number of very small stones may not have played any rôle in the obstruction. In 1878, Jean [6] reports a case in which death occurred in the course of attempts to relieve retention. This case was of the same type as the preceding—a very large prostate containing lacunae filled with small black stones. Age of patient, 63. One year

later Hautesson[7] reported a case in a man of 66 in which prostatic calculi were known to be present, as such had been passed from time to time. The catheter was required now and then, probably before the stones escaped from the organ. Not all of these were voided externally, for some passed into the bladder, there to form vesical calculi, for which litholapaxy had once been performed. Per rectum, the prostate felt soft and compressible, most of the stones having doubtless escaped from a cavity in the gland. This case may not belong properly in the series, although only the occasional escape of the stones could have prevented permanent obstruction. In 1909, Cholzoff[8] reported a case aged 68, obstruction having been due to the stone itself. Rectal examination revealed an enlarged prostate which contained numerous concrements. A perineal prostatectomy was performed and almost the entire gland was removed because of the presence of the latter. Ekehorn's[9] case in a man aged 69, reported in 1908, gave history and symptoms of ordinary enlarged prostate leading to catheter life. Diagnosis of prostatic calculus made after suprapubic cystostomy and 40 stones were curetted from the gland after dilatation of the sphincter. Death four months later from marasmus, when both kidneys were found atrophic. The patient had developed a pelvic abscess as a result of intervention. In 1909 Thomas[10] reported two cases. One was a typical enlarged prostate in a man of 63, ending in retention (the surgeon could pass only No. 6). Suprapubic cystostomy revealed the presence in the prostate of a pocket of stones. Incision wound infected and a counter-opening was made in the perineum. The second case was similar (age 62) and the bladder already septic. Eight small stones were removed through a suprapubic opening and the patient recovered.

In studying these cases, it is interesting to note that in several—namely, those of Robin, Jean and Thomas (2nd case)—the hypertrophic increase in the size of the gland was

apparent and justified the operation of suprapubic incision and prostatectomy and the calculi in these cases evidently were incidental to the senile hypertrophy.

The first case of J. Lynn Thomas,[10] as cited in brief, more closely resembles the cases encountered by me, except as regards the enlarged gland. Two of the cases reviewed—that of Thomas and one reported by Ekehorn—were followed by post-vesical abscess and, as will be shown later, one of my cases had a similar condition and it may be possible that in our endeavor to do a thorough operation, we broke through into the fascia and carried infection thereto.

My first case operated upon was in a man, 42 years of age, who gave a history of urinary trouble extending over a period of twelve years: for past four years had been on catheter life. Cystoscopic examination was negative, other than that the vesical sphincter had to be dilated to admit the instrument. The hypertrophied trabeculated bladder held 448 cc. By rectal examination the prostate was apparently normal and was not sensitive to palpation and there was no evidence of cord lesion. Pre-operative diagnosis was not made and the patient was so informed. Suprapubic incision was consented to as an "exploratory measure." The internal urinary meatus was of the pin-hole type and was dilated with the index finger with difficulty; it finally gave way and in the attempt to enlarge it, the finger broke through into a sac of small stones which, when removed, left practically no prostatic tissue. The patient made a good recovery and has a normal urinary function and no residuum.

In another case, in a man 48 years of age, there was practically the same history of urinary trouble for a long period of time, the same failure of pre-operative diagnosis and the same pathological conditions discovered at operation. Patient did well until the 10th day, when he developed pneumonia and died. At autopsy, an abscess was found "under the floor of the bladder," and the pulmonary lesion was classified by

the pathologist as a septic pneumonia resulting from the abscess in the vesico-rectal region.

The third case seen differed from the other two in that the most important symptom with him was a terminal hematuria, accompanied with the usual history of increasing urinary symptoms. Examination, tending to the arrival at a pre-operative diagnosis, was as unsatisfactory as in the other cases. An "exploratory" showed the same type of obstruction and due to the same pebbly prostate. The patient was discharged from the hospital before his suprapubic wound was closed, and when I saw him six months following, he was not passing any urine by the urethra and all of it through his suprapubic fistula; it did not dribble and to certain extent he had control of his urinary function, as voluntary contraction would give a projectile stream; a catheter or sound passed to the bladder had but limited motion and no urine would run through the catheter. It is needless to remark that I was displeased with the result and requested him to return for further treatment. In going into the bladder, by following down the suprapubic sinus, I found that the sound and catheter passed into the sac of the prostate, which had roofed over and thus closed the internal meatus. Cutting through and dissecting out the sac, I placed in a large calibered retention catheter, allowing it to remain until the suprapubic wound healed. From last reports, all was well.

"Phosphatic calcareous deposits may incrustate upon the mucous membrane of the prostatic urethra, extending into the follicles, favored by morbid conditions of the mucosa and ammoniacal deposits of urine, but true prostatic calculi are developed primarily in the follicles of the gland and are derived from the precipitate of salts of the prostatic secretion" (Chetwood).

The symptoms given by Chetwood are "those of prostatitis and urinary obstruction, mainly pain and dysuria, sometimes accompanied by hematuria and purulent urine."

In all cases, the history of urinary disturbance extending over a period of several years was revealed, characterized by painful and frequent urination with and without blood; in only one of my cases was a history of the passage of gravel given. Examination, as stated, led to nothing except an obstructive condition at the neck and in no wise suggested the presence of calculi. I anticipate the interrogation, "What difference does it make whether calculi are present or not, so long as the indication to remove the obstruction is present?" and I grant this question is pertinent; but in the present age of exact urinary diagnosis, it is disappointing to expect to find simple fibrotic prostate and distorted sphincter, and, instead, find a stone quarry.

This subject has been advanced by me to try and bring out in the discussion the question of diagnosis, likewise of treatment other than perineal or suprapubic removal of calculi and obstruction, perhaps by means of the operative urethroscope or cystoscope in the hands of experts. Removal of the obstructions in these cases was my object and while they were approached suprapubically, in the future I will attack all small fibrotic prostates, with or without stones, through the perineum; as it is most difficult for me to dig out a small gland from above.

Conclusions

In the cases seen by me and in those reported, the preoperative diagnosis of the true pathology was not made except in Manzoni's case.[4] Microscopical study of the urinary sediments gave no clue to the diagnosis.

Hematuria was present in one of my cases, and in some of the cases reviewed and with the absence of other definite causes in obstructive conditions, may act as a diagnostic lead.

Difficulty of catheterization and evident contracture of the neck should be considered suspicious as occurring in calculous prostate.

The history of gravel is important, as in two of my cases such a history was obtained and Hautesson mentioned it in his case;[7] the other authors reviewed made no mention of it.

The text-books emphasize the finding of a "small sac of stones" by rectal palpation; this was not so in my cases, and no mention was made of it by the authors reviewed.

Final Conclusion.

From conversation with several X-Ray men, I have learned that occasionally calculi of the prostate are discovered, but, as far as they know, it is not a routine practise among genito-urinary men and it would seem to me that this aid to diagnosis should be taken advantage of when cases are slow to respond to ordinary treatment.

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[10] Thomas: Am. Jour. of Urology, p, 224.

PROSTATITIS IN MEN PAST MIDDLE LIFE

By William P. Willard, M.D., of San Francisco

IN studying this subject I have taken forty cases, and only those that have had no venereal trouble, no residual urine, and with no appreciable change in the prostate, either on palpation or cystoscopically. Many of the cases that were first included in this group proved on further study to be cases of beginning prostatic hypertrophy.

Almost all of the patients were of sedentary habits and had reached the time of life when they thought more of avoiding exercise than of taking it. Constipation was present in all. The automobile seems to play an important part in the etiology, and many of these patients date their first symptoms to some long or rough motor trip.

Hyperemia, due to a changed sexual life, appears to be a factor in some cases. These patients, after many years of regular intercourse, have had a sudden break due to the death or ill health of their wives. There remains a strong sexual desire with erections and emissions, but the normal depletion of the parts that occurs after intercourse is lacking, and probably enough change occurs in the gland to render it liable to infection.

The infection of the prostate from foci of infection in distant parts of the body undoubtedly occurs, and many cases have been reported. Wildbolz, in a recent article, remarks that germs of all kinds may reach the prostate through the blood or lymph from remote foci, and that the prostate offers peculiarly favorable conditions for colonization of germs. He reports 14 cases after grippe, and in other cases tonsillitis or

bowel trouble preceded the prostatitis. In a patient with a furuncle, with subsequent prostatitis and perinephritic abscess, he found staphylococci in all lesions.

Five of my cases first noted their prostatic trouble after grippe.

Of course it is difficult to know whether or not the prostatic condition was latent and simply accentuated by the lowering of the general resistance by the disease, but it seems likely that the infection occurred just prior to the manifestation of the symptoms.

In many cases I could find no cause for the symptoms, and have always been under the impression that there must be some structural change in the prostate after middle life that renders it liable to infection from the rectum. I have discussed this with many men who have studied the gland histologically, but nothing was suggested that would bear this out.

Lowsley recently pointed out that a change occurs in the subcervical group of glands at this time of life. He states that he has found an enlargement of a small group of glands on the floor of the bladder orifice (subcervical group) in about 25% of the cases over thirty years of age and much more frequently after that. He further says: "The matter of congestion and the presence of this pathological structure in the region of the prostate probably precedes the infection, which, in my opinion, undoubtedly may occur through the lymphatics and blood supply due to the proximity of the rectum. It is not hard to conceive of colon bacilli being carried through the hemorrhoidal vessels which supply the prostate with blood."

Constipation is undoubtedly an important aid in the infection of these glands. Where the rectum is filled a large part of the time, the circulation of the rectal mucosa and of the prostate must be interfered with.

In reviewing the literature on the bacteriology of the

prostate, much doubt is expressed as to the correctness of the findings on account of urethral contamination. I also realize that my findings are not an accurate statement of the actual infecting organisms in many of the cases.

In collecting the prostatic secretion and in culturing I used various methods, but as it is impossible to obtain secretion that has not first entered the urethra, all methods are open to criticism. The cultures that showed staphylococci only, I did not consider of much value on account of the liability of this contamination.

I obtained a pure culture of colon-like bacilli three times and with other organisms fourteen times. In two cases pure streptococcus cultures were obtained.

Culver, in a study of the bacteriology of chronic prostatitis, found that anaerobic as well as aerobic organisms may be the cause of the infection. As I made no examination for anaerobic organisms, I may have missed in some cases the true cause of the lesion. Culver, however, found anaerobes alone in only four of his cases.

The symptoms complained of by these patients were numerous. As you would expect from this organ, many complained of sexual symptoms. The lack of sexual desire was noticed by many. Some were unable to get erections. Pain at the time of ejaculation was complained of by two men.

Urethral secretion was the only symptom in two cases, and the passage of a small amount of blood at the end of micturition in one case. Pus in the urine, found on life insurance examination, brought two patients.

Frequent urination was a common complaint. This was not always constant, but was easily provoked by intercourse, drinking or automobiling. Pain and pressure in the perineum and rectum were complained of, and a dull pain low in the back was a common symptom.

In none of the cases was the prostate enlarged, hard or extremely sensitive. The variations in density, as elicited

by the palpating finger, are so great as to be rather confusing as a diagnostic point.

I found in quite a few cases distention of the vesicles, but in none were they appreciably infected.

The length of the urethra was not increased.

Cystoscopically nothing was found, the bladder mucosa being normal and the sphincter outline regular. In the posterior urethra as a rule the mucosa was injected and the verumontanum more prominent than normal.

The prognosis is fairly good, and if the patient is careful regarding his habits and his general care the condition is not prone to recur.

The treatment I have used consisted of placing the patient on a bland diet with plenty of fluid; regulating the bowels and prescribing definite exercise; avoiding automobiling, alcoholics, and carbonated drinks. Intercourse should be forbidden during the treatment. Warm sitz baths are of benefit.

The local treatment consisted of prostatic massage twice a week, with instillation of either ¼% nitrate of silver or 1% hegonon solution. Autogenous vaccines were used in a number of these cases with no definite results.

From my study of these patients I have concluded that in men past middle life the change in the prostate due to the interference with circulation and the subsequent infection, together with the enlargement of the subcervical group of glands in the posterior urethra, lead to many symptoms that are liable to be interpreted as prostatic hypertrophy or beginning hypertrophy, and to unnecessary surgical measures.

On account of the relatively large number of cases in which colon-like bacilli were obtained, and the fact that colon bacilli are not often found in the urethra or prostate, leads me to believe that many of these prostates are infected from the lower bowel.

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TABLE OF CASES (Dr. Willard)

	Age	Occupation	Duration of Symptoms	Symptoms	Sexual Power	Organism	Pus in Secretion
1	52	Merchant.....	10 yrs.	Intermittent attacks, frequency and burning	Diminished	Colon.	+++
2	49	Secretary.....	3 mos.	Frequency, imperative desire	Diminished	Colon staphylococcus	++
3	63	Lawyer.....	6 yrs.	Frequency	Absent	Streptococcus	++++
4	47	Promoter.....	1 yr.	Pain in perineum	Diminished	Colon staphylococcus	++
5	44	Lawyer.....	2 weeks	Mucopurulent urethral secretion	Unchanged	Staphylococcus	+++
6	54	Merchant.....	6 mos.	Frequency	Diminished	Colon diphtheroid	++
7	73	Lawyer.....	10 yrs.	Frequency	Absent	Streptococcus	++
8	38	Merchant.....	1 yr.	Urethral secretion. Pain in perineum	Unchanged	Negative	++
9	65	Capitalist	8 mos.	Unable to get erections	.....	Staphylococcus	+
10	54	Merchant.....	3 yrs.	Pus in urine, frequency at times	Diminished	Diphtheroid colon	++
11	50	Editor.....	6 weeks	Urethral secretion	Unchanged	Negative	++
12	48	Merchant.....	8 mos.	Urethral secretion	Diminished	Colon strepto. staphylo.	+++

	Age	Occupation	Duration of Symptoms	Symptoms	Sexua Power	Organism	Pus in Secretion
13	53	Merchant.....	1 yr.	Frequency	Diminished	Colonstaphylo.	++
14	47	Mining engineer.	3 weeks	Urethral secretion	Unchanged	Streptococcus	++++
15	49	Merchant.....	2 yrs.	Diminished sexual desire	.....	Negative	+
16	48	Lawyer.....	8 mos.	Frequency	Diminished	Colon staphyl.	++
17	53	Merchant.....	1 yr.	Frequency	Diminished	Colon diphtheroid	++
18	46	Merchant.....	2 yrs.	Frequency	Unchanged	Negative	++
19	48	Merchant.....	1 yr.	Urethral secretion, pain in perineum	Unchanged	Staphylococcus	++
20	38	Engineer.....	6 mos.	Frequency	Unchanged	Colon staphyl.	++
21	66	Watchman.....	1 yr.	Unable to get erections	.....	Staphylococcus	+++
22	45	Superintendent..	3 yrs.	Pain in perineum	Absent	Staphylococcus diphtheroid	++
23	42	Merchant.....	1 yr.	Frequency and burning	Diminished	Negative	++
24	50	Merchant.....	6 mos.	Frequency	Unchanged	Colon	+++
25	52	Captain of Firemen	1 yr.	Burning, frequency	Diminished	Staphylococcus colon	++
26	52	Merchant.....	3 mos.	Frequency	.....	Staphylococcus	++
27	48	Conductor.....	2 yrs.	Intermittent frequency	Unchanged	Streptococcus colon	+++
28	53	Agent.....	1 yr.	Painful erections, frequency	Absent	Negative	++
29	51	Agent.....	2 yrs.	Frequency	Diminished	Staphylococcus	++
30	56	Merchant.....	2 mos.	Frequency	Unchanged	Staphylococcus	++
31	45	Clerk.....	6 mos.	Frequency	Unchanged	Staphylococcus	++
32	59	.....	2 yrs.	Frequency and burning	Absent	Colon	+++
33	65	Teacher.....	10 yrs.	Intermittent, frequency	Absent	Streptococcus colon	++
34	40	Physician.....	1 yr.	Pain in perineum	Unchanged	Streptococcus	+
35	45	Agent.....	2 yrs.	Painful erections	Diminished	Staphylococcus	++
36	48	Teacher.....	1 yr.	Frequency	Unchanged	Negative	++
37	48	Merchant.....	2 mos.	Urethral secretion, pain in perineum	Diminished	Staphylococcus diphtheroid	+++
38	38	Buyer.....	Unknown	Pus in urine	Unchanged	Staphylococcus	++
39	38	Artist.....	2 mos.	Pain in perineum	Diminished	Colon diphtheroid	+
40	45	Banker.....	1 mo.	Blood at end of micturition	Unchanged	Staphylococcus colon	++

DISCUSSION

DR. A. L. CHUTE, Boston: In connection with Dr. Townsend's paper, I would like to relate a case that I saw several years ago. The patient complained of urinary obstruction and pain. The prostate was rather hard, and on palpation I could get that perfectly typical creaking sensation that I believe is pathognomonic of multiple calculi. A very good radiograph showed some stones arranged in a sort of crescentic shape in his prostate. I have here a lantern slide of the radiograph and the stones which I removed. The man made a perfectly good recovery. I removed these stones by the perineal route, making the usual perineal incision and then carrying the dissection down to the prostate. The capsule of the prostate was incised transversely and the calculi scooped out.

DR. H. L. KRETSCHMER, Chicago: With reference to Dr. Townsend's paper, I should like to report briefly three cases that I saw in which the diagnosis was made by the X-ray. In two of the cases we were unable to obtain the crepitation that the text-books tell us is present.

One of the patients was a young man, twenty-three years of age, who complained of frequency without infection or residual urine. The cystoscope showed a large number of small stones in the bladder which were removed with the evacuator. He was cystoscoped afterwards and his bladder demonstrated to be free of calculi. I then had him X-rayed and the X-ray showed the presence of fifteen or twenty stones in the prostate.

The second case was a man aged sixty in whom the X-ray showed calculi in the prostate and also the presence of a stone in the left ureter and possibly a stone in his left kidney. This man had no residual.

The third patient was a man of fifty, who ten years ago was operated upon for calculi in the prostate, which were removed by a perineal operation. He came back with his old symptoms of frequency and pus; there was no residual. On rectal examination I was able to demonstrate a sensation of creaking. The stones were very large and I was able to palpate them.

Undoubtedly the safest way to recognize prostatic calculi is by the Roentgen Ray.

Dr. R. F. O'Neil, Boston: I should like to mention a couple of cases of calculus of the prostate which I have operated on at the Massachusetts General Hospital. One was a man with quite a large calculus in the prostate, which was shown by the X-ray and felt by a metal instrument in the urethra and also by palpation. The prostate was unusually hard, but the man's age, as I remember it, was against malignancy; we made the diagnosis of stone in the prostate from the radiograph and from the grating sensation in the urethra. It was removed by the perineal route.

The other case on which I did a suprapubic operation for urinary obstruction turned out to be a chronic prostatic abscess with a couple of small calculi in it.

Although the end result was excellent, I think the perineal route would have been easier and given better drainage. The upper route was chosen on account of the great difficulty of getting into the bladder at times. At such times instruments were undoubtedly passed into the abscess cavity.

Dr. H. A. Fowler, of Washington: In discussing calculi of the prostate it is necessary to keep clearly in mind that there are two distinct groups of cases. In the first the stone is of urethral or urinary origin—that is, the stone is formed at a higher level and descends into the prostatic urethra, where it is arrested. In this location it may undergo further growth and become buried in the prostatic tissue, sinking deeper and deeper within the substance of the gland.

The other group of cases is more unusual, I believe, and represents true autochthonous calculi of the prostate gland. These calculi are formed within the prostate gland itself and have no relation whatever with the urinary calculi. I may refer briefly to one patient I have already reported, the only one that has come under my observation. There was nothing unusual in the examination, only a benign hypertrophy. During the operation for the removal of the prostate, as we were proceeding with the enucleation, our finger came in contact with a gritty material lying between the adenomatous growth and the capsule proper. After removing the prostate we found the bottom of the cavity lined with a calcareous material, and, scooping it out with the

finger, we found a large number of very small minute brownish colored stones, varying in size from that of a mustard seed up to a very small pea. We were able to recover 152 of these small calculi. It seemed that in this case the origin of the stones was quite different from that in group one. They could have had no connection whatever with the urethra or the urinary tract, but formed *in situ*. As to the mode of formation I am not quite clear, but probably they had their origin from the corporea amylacea of the prostate, and by successive growth formed within the tissue of the prostate.

Recently in operating with my assistant, Dr. Hooe, we encountered a second case, identical with the one I have just recounted.

I do not know that there is any particular interest in these cases further than the unusual character of the stones present complicating an adenomatous growth of the prostate. I might say that in the first case the patient had stones in the bladder, but these were distinctly and entirely separate from the prostatic calculi, which we think were autochthonous—formed in the prostate—and had no connection with the stones in the urinary tract.

Dr. John H. Cunningham, Jr., Boston: I quite agree with Dr. Fowler's classification of these stones. I have had two patients where, in enucleating the prostate, we found some of the sandy material the doctor speaks of.

A few months ago I had a stone that I believe to be of urinary origin, which was located in the prostatic tissue directly beneath the vesical sphincter. The patient had a residual urine of three ounces. The cystoscopic examination was negative, but with the deep urethroscope one could see this stone sticking from its bed in the prostatic tissue into the prostatic urethra. It was impossible to dislodge it through the urethroscope, and I did a perineal section and removed it. The vesical neck was found very much sclerosed. It would only admit a 25 F. sound, and was very hard and fibrous. The vesical sphincter was divided by one incision with a knife. The patient made an uneventful recovery, went home, and three weeks later developed the worst epididymitis I have ever seen. The patient was in the country under the care of a physician who did not realize the situation. The abscess developed to such a degree that it ruptured into the tunica vaginalis, and the greater part of the scrotum sloughed off. It proved to be a colon infection. I think that colon infection might

very well have taken place as Dr. Willard has explained in his paper, as the urine, when he left the hospital, was quite normal, and the perineal wound entirely healed.

Dr. Hugh Cabot, Boston: I want to discuss for a moment Dr. Willard's paper on the question of the origin of the organisms in the prostate. The striking thing I think about these infections of the prostate, other than gonococcic, is that the organisms correspond very accurately in their relative frequency with the organisms which infect the kidney, the colon bacillus being the most common, after that the staphylococcus and then the streptococcus and various other organisms trailing along. It seems to me on this ground, if on no other, one should be inclined to take the view that the method of infection of the prostate is probably the same as that of the kidney. Now more and more we are coming to take the view that the kidney infections reach the kidney through the blood and less and less that they reach the kidney by the lymphatics. The earlier view that the infections of the bladder commonly resulted via the lymphatics from the rectum has been abandoned. Now it is striking that there is a group, at least of these cases of prostatitis, which follow septicemias, typhoid, colon, coccus, in known cases. Then the rather rarer cases of the pneumococcus prostatitis and the cases of influenza prostatitis, coming on during a perfectly definite septicemia with this class of organisms. I have seen a small group of cases that alternately have colon bacillus pyelonephritis and colon bacillus epididymitis and prostatitis.

It seems to me that we must be careful not to overlook the probability that the blood stream, whether directly to the prostate or via the epididymis with its excretory function, is the origin of these infections. I believe the vast majority of them are bacillemias primarily, and secondarily an infection of the kidney, of the prostate or of the epididymis. I doubt a good deal whether it would be possible to show that the organism, so to speak, goes across lots from the rectum. It does not appear to do so elsewhere, and I doubt if it can be shown here.

Dr. F. R. Hagner, Washington: I would like to report a case in line with what Dr. Cabot has spoken of. This occurred in a doctor. This gentleman had no history of any urethral infection at all. The patient had a typical attack of grip, and within three days after this started quite a severe prostatitis developed, in which we found no

organisms on culture or slides, and within two days he developed an epididymitis; the epididymitis was not very severe, and only lasted four or five days. This man was quite a careful observer; he had had his urine examined frequently, and there had never been any evidence of disease, and I think possibly it was due to this grip infection that he had.

Dr. Townsend (closing): I have nothing to add except that I tried to bring out in the paper the differentiation, as Dr. Fowler pointed out, between the so-called primary and secondary calculi of the prostate.

Another point is that the cases of calculous prostate reported by me were young subjects, men around thirty-five and forty years of age, and there were no symptoms that led me to believe that they might have a benign or a malignant hypertrophy.

I want to emphasize one point brought out in this discussion, and that is that in prostatic disease with symptoms as given, I believe that the use of the X-ray, not occasionally but as a routine, would help us materially in arriving at a diagnosis of prostatic calculi.

Dr. Willard (closing): I have nothing much to add except in reference to what Dr. Hagner said. In the cases that I had following influenza and in the cases reported by others the influenza bacillus was not recovered on culture. It seems to be very difficult to grow from the prostatic secretion after these infections.

A TECHNIC FOR SUPRAPUBIC PROSTATECTOMY UNDER LOCAL ANESTHESIA

By Benjamin S. Barringer, M.D., of New York

LEGUEU (Anesthesie Locale de la Prostatectomie, Journal d'Urologie, June, 1914), in 1914, suggested the possibility of local anesthesia prostatectomy, describing the technic and various-shaped needles with which the prostate might be anesthetized through the suprapubic opening. In the four cases here reported I have tried different methods of anesthetizing the capsule of the prostate. While in each the method has varied, and while in but one was the preliminary dose of morphine given, in each I succeeded in completing the operation using only local anesthesia.[1]

Technic. A preliminary dose of ¼ grain of morphine is given one-half hour before the operation. The bladder is opened, using a median incision and the usual technic by local anesthesia. The opening in the bladder is high and wide enough to introduce two fingers; ½ or 1% novocain is used both to anesthetize the skin, the bladder and the sheath of the prostate. The bladder opened, the prostate and its sheath are thoroughly infiltrated with 1% novocain, using a 4-inch 18-gage needle. Particular care is taken to anesthetize the portion of the prostate sheath between the lateral lobes (to the depth of ½ to 1 inch) as this is where the first tear into the sheath is made and where pain may be expected. During these manipulations a gloved finger of the left hand is intro-

[1] At first I tried to anesthetize the prostatic urethra and the capsule of the prostate by introducing a 4-inch 18-gage needle through the perineum into the prostate, a guiding finger being in the rectum. This does not seem to work as well as doing the whole operation suprapubically.

duced into the rectum and this is used both as a guide to the infiltration and to lift up the prostate. The glove is taken off the right hand—the hand which is used for the intravesical manipulations. After waiting about 5 minutes, the index finger of the right hand tears through the superior wall of the urethra into the prostatic sheath, following the technic of Squier. I believe that a slight cut with scissors or knife through the urethra would probably be better and less painful than tearing all the way through with the finger. When the patient feels pain the tearing is stopped and the prostatic sheath further infiltrated, the infiltration keeping pace with the operation and with any suggestion of pain experienced by the patient. The finger in the rectum prevents the needle from going too deeply. With great gentleness and using all the time that is needed (the whole operation takes from 30 to 40 minutes) the prostate is shelled out. If the final shelling out causes too much pain, a whiff of gas can be given to the patient. I think, however, that this will be rarely necessary if the operator calmly takes his time. I believe it is the hurry to get the prostate out that in most cases causes pain.

Pain vs. Shock. Three of my patients had some slight pain; one had considerable pain because I attempted to remove lateral lobes which did not exist. This last patient had a slight amount of shock as shown by some paleness and sweating of the face and slightly increased pulse rate. The other three had absolutely no shock; their pulse stayed precisely the same as before operation. The last patient, after the removal of a good-sized prostate, was sitting up in bed reading the paper when I left the hospital. It is a question if it is not better to let a patient feel a slight amount of pain if by so doing you can keep from using a general anesthetic and perform a serious operation with no shock. I believe most patients would rather bear such slight pain than have a general anesthetic, but I also believe it is a question how

much pain you should let a patient bear before resorting to a few whiffs of gas or ether; ½ or 1% novocain has been used in as large quantities as necessary to anesthetize the sheath of the prostate. Novocain seems to be practically non-toxic. Of course I should hesitate to use more than 4 or 5 grains for the entire operation. The following is a brief résumé of the four cases:

Case 1. A. M. Age 66. History of urinating for some months two to four times at night. The prostate was enlarged rectally and cystoscopy shows a bifurcate middle lobe. He had 16 ounces of residual urine when first seen and when operated upon had complete retention. Blood pressure 156. Intramuscular phenolsulphonephthalein appeared in 25 minutes and 45% was excreted in the first hour thereafter.

Bladder opened under novocain and the capsule of the prostate infiltrated with novocain and the prostate removed. He had some slight pain at the final shelling out of the prostate. The suprapubic wound closed up two weeks after operation. His convalescence was complicated by a popliteal phlebitis. Two months after operation he was getting up two or three times at night, had a residual of 2 drams.

Case 2. P. L. Age 69. History of difficulty in urinating for fifteen years. Two weeks before seen, complete retention. Later he partially regained control and had from 6 to 8 ounces of residual urine. Phenolsulphonephthalein appeared in 7 minutes, 42% in the first hour, and 17% in the second. He had a large prostate by rectum and the cystoscopy showed an irregular horse-collar prostate. This patient was given preliminary infiltration anesthesia of the prostate by means of a needle introduced through the perineum. This was supplemented by anesthetization of the prostate capsule through the suprapubic wound; ½% novocain was used to anesthetize the skin and bladder, and 1% the prostate and its capsule. Slight pain was felt at the final shelling out of the prostate,

but the patient had practically no bleeding and no shock. Bladder wound closed on the sixth day so that he was passing all his urine by urethra. When the patient left the hospital two weeks after operation he had no residual.

Case 3. J. Age 65. Comes with a history of night urination for some time; up three or four times. Residual urine about 3 ounces. Cystoscopic examination showed a median lobe enlargement of the prostate. Phenolsulphonephthalein output normal. The bladder was opened under novocain and it was attempted to get any lateral lobes which might be present. No lateral lobes were present, and in this attempt the patient was hurt considerably. The median lobe was taken out without trouble. He left the hospital three weeks after operation with his suprapubic wound healed and with dram 1 of residual.

Case 4. X. This patient was operated upon at the Nyack Hospital and a suprapubic incision had been made two weeks before I saw the patient. He was a man of about sixty; he came to the hospital with complete retention and he had a very large prostate by rectal feel. No cystoscopy was done and no preliminary functional tests. The suprapubic wound was granulating and I hurt the patient more in opening this up and getting into the bladder than doing the prostatectomy. The prostate was anesthetized with novocain and shelled out. It was so large that I had to deliver it through the suprapubic wound with a pair of forceps, pulling quite vigorously to get it out. The patient had no shock and no bleeding. The wound was packed with gauze and the patient was sitting up in bed when I left the hospital. I did not see him thereafter, but heard from his physician that he had left the hospital about a month later. The wound healed nicely but he was not tested for residual urine.

Summary

In most cases prostatectomy can be accomplished under local infiltration anesthesia and if it is so done the shock of operation, the trauma of tissues and possibly hemorrhage are apparently less than if a general anesthetic is used. Novocain is the anesthetic of election. The operation takes longer than when done under a general anesthesia.

TWO CASES OF POST-OPERATIVE HEMORRHAGE, FOLLOWING SUPRAPUBIC PROSTATECTOMY

By F. R. Hagner, M.D., of Washington, D. C.

IN our experience with prostatic surgery, we have had three cases that have had secondary hemorrhage twelve to fourteen days after the removal of the prostate. The condition that obtained in all of the cases, stood out prominently and was probably the cause of the late hemorrhage, was arteriosclerosis and high blood pressure.

The first case has been previously reported and occurred twelve years ago in a man seventy-six years old. In this case the hemorrhage came on twelve days after the operation while the patient was at stool and he practically bled to death while in this position. The superficial wound was nearly closed, but when the skin was opened in an endeavor to control the hemorrhage the wound appeared as if it had just been operated upon and with no attempted healing. This was a perineal case. The patient never rallied and died from the loss of blood.

The other two cases occurred after suprapubic prostatectomy and within the past year. The first was a patient eighty-nine years of age and with a very large intravesical prostate. The prostate was removed and the patient appeared to do very well, no hemorrhage occurring after the removal of the gland. This gentleman was about his room and apparently convalescing. On the fourteenth day after the removal of the prostate he had a violent hemorrhage. When my assistant, Dr. Fuller, and I arrived at the hospital the hemorrhage had ceased. We removed the clots from the bladder and

thought best to allow the patient to be perfectly quiet. This was at seven o'clock in the evening. There was no return of the bleeding until eight o'clock the next morning, when another hemorrhage came on that nearly caused the death of the patient. We at once placed a prostatic bag for controlling hemorrhage in position and although the bleeding was very profuse at this time the hemorrhage was immediately controlled. This bag was allowed to stay in place for forty-eight hours. It was then removed and the patient went on to uninterrupted recovery.

The second case occurred in a patient seventy-eight years of age. At operation a fair-sized intravesical prostate was removed, and 12 days later a hemorrhage occurred. I was summoned early one morning by the internes at the hospital because of a very severe hemorrhage taking place through the suprapubic wound. On arrival it was found the patient had lost a great deal of blood and was in an exhausted and weakened condition, pulse being weak and very rapid. The bag was at once introduced and the hemorrhage was immediately controlled. As in the former case, the bag was left in position for forty-eight hours and then removed. There was no recurrence of hemorrhage and the patient went on to uninterrupted recovery.

None of these cases had any hemorrhage before the operation nor any undue bleeding at time of operation. As stated in the beginning of the report, the condition present in all the cases was high blood pressure, from 190 to 200, and I believe that this probably has some bearing as a cause of the hemorrhage. Whether these patients had a sudden attack of high blood pressure and the granulating wound, being the weakest point, allowed the vessels to rupture, I am unable to say. In the first case, as mentioned, there was no attempted healing of the wound, while in the other two cases, on palpation of the wound with the finger, the cavity appeared con-

tracted and in such condition as you would expect to find the capsule after an operation of this kind. I feel sure that the prompt control of the severe hemorrhage probably saved the lives of these two patients.

PRELIMINARY REPORT ON THE TREATMENT BY RADIUM OF CARCINOMA OF THE PROSTATE AND BLADDER[1]

By Benjamin S. Barringer, M.D., of New York

IN October, 1915, at the Memorial Hospital, we began treatment by radium of cases of carcinoma of the prostate and bladder. At this early date obviously no final results of our treatment can be predicted. In certain cases, however, our primary results have been good. This, together with the fact that the technic of the application of the radium, particularly in carcinoma of the prostate, is new, encourages us to give this report.

It has been possible to carry out this work because of the cooperation of three men—Dr. Janeway has given valuable advice as the radium expert of the hospital; Dr. Keyes has very generously contributed advice, corroborating examinations, and material; while Dr. Ewing has suggested ways and means and made all the pathological examinations. My grateful thanks are due to these three.

The problems presented by carcinoma of the bladder and prostate are so entirely different that they will be considered separately.

Carcinoma of the Bladder

The cases considered in this paper are not papillomata which may have undergone at one place or another carcinomatous degeneration, but rather flat sessile tumors, sometimes

[1] From the Service of The Memorial Hospital.

cauliflower, sometimes hard, sometimes multiple, generally sloughy in part. The cystoscopic picture or the rectal feel may suggest an indurated base. Microscopically they show carcinoma. Fulguration does not particularly affect this tumor.

Technic of Using Radium. There are a number of different facts connected with these tumors which have determined our method of treatment.

1. These patients often have a great deal of pain, both connected with and between urinations. We have tried not to increase their pain and discomfort; in other words, if we do not succeed in curing, we can at least say that we have not made them materially worse. We have not been altogether successful in this. The extent of the carcinoma, the presence of urinary retention, the involvement of the prostatic urethra, and other factors, seem to make it more or less impossible to accurately determine the amount of pain a patient will have from radium treatment.

2. In the first case in which we used radium, the bladder was opened suprapubically and the radium attached by hooks to the tumor. It took this man nearly three months to get out of the hospital. He had sloughs in his suprapubic wound for a long time and his physical condition at present is the worst of any of the patients treated. For this reason I have at least temporarily given up this method.

3. I believe that the problem of destroying carcinoma of the bladder by radium is, in most cases, largely one of accuracy in applying the radium to the growth. This has been the experience of those who have used radium treatment in uterine carcinoma. Therefore we have not used irradiation by means of rectal tubes or suprapubic application, but have tried to place the radium on the growth in the bladder. I have tried to use the radium in such quantities and over such periods of time that undue sloughing and burning of the normal portion of the bladder will not result.

The method which I use at present is as follows:

One hundred to 200 millicuries of radium screened with .6 millimeters of silver and 1.5 mm. of rubber are put up so as to form a capsule about one inch long and ⅛ of an inch in diameter; to this is attached a long stout double linen thread. A direct cystoscope is introduced into the bladder, the capsule put through its sheath and the cystoscope withdrawn, leaving the radium in the bladder, the linen thread attached to the tube runs through the urethra and appears at the meatus. In women, one may reintroduce a small cystoscope and see if the radium lies upon the tumor. The patient remains in bed during the application. This perhaps is a crude and inaccurate way of applying the radium. On the other hand, a large majority of bladder carcinomas are in the base and the tube of radium cannot be very far from a carcinoma in this position; certainly much nearer than a rectal or suprapubic tube would be. If the carcinoma is located on one side of the bladder the patient is told to turn slightly toward that side while the radium is applied. The patients generally have been able to urinate without trouble during the application. Some have held their urine until the end of the irradiation, at most eight hours, and then urinated or were catheterized after the radium was removed. The urine possibly to some extent screens the vault of the bladder (all of my patients to date have had carcinoma of the base) and also lifts the bladder mucous membrane of the vault away from the radium. Whatever may be the reason, the normal bladder mucous membrane seems very resistant to radium burns when the radium is used in this way.

Duration of Radium Burn. There is much irregularity in the effect of any given dose of radium. The radium does not, as a rule, change the appearance of the tumor; that is, a red cauliflower tumor generally remains red after the radium burn, but it appears to be softer, and fulguration of the tumor has a much greater effect than before the irradiation. On the

other hand, sloughing sometimes occurs and persists even for a number of months. My rule is not to reapply radium until a patient has entirely recovered from the effects of the first application.

Dangers of the Use of Radium. I have lately heard of one case in which radium was used, quantity, time or screening not known, in which the patient some two and one-half months after the irradiation had a ruptured bladder and died. This case emphasizes the fact that if the tumor is at all extensive it is very difficult by the cystoscope to tell exactly the amount of bladder involved. Cystographs may help some. It is possible that further experience will indicate that we should, in extensive carcinomas, do a suprapubic observation of the exterior of the bladder. If we find that the carcinoma has penetrated the bladder, radium treatment is probably both useless and dangerous.

Report of Bladder Cases

Nine bladder tumors have been irradiated.

Extent of Growth. In one of these cases the growth was absolutely inoperable. In another case the growth should be classed as a prostatic carcinoma with secondary invasion of the bladder. In five other cases the extent of the growth indicated that total cystectomy would have been the only operation to offer anything. In another case, partial cystectomy, with the reimplantation of the left ureter, would have been possible, while in another the growth itself possibly could have been removed.

Microscopical Examination. In six of the nine cases the diagnosis of carcinoma has been confirmed by the microscopical examination of pieces taken from the growth. I believe that in all cases the diagnosis must be confirmed by the microscope. But when once confirmed, the cystoscopy and the rectal feel give us much more trustworthy data as to

the extent of the tumor and the prognosis in a given case than does the microscope.

Result of Treatment. One case died three months after irradiation. This case had an extensive inoperable carcinoma of the bladder base; three cases have been too recently treated to make any report. Another case is definitely getting worse. This is the case in which the radium was applied through the suprapubic opening in October, 1915. I have never been able to cystoscope this patient to see the effect of the radium on his bladder, but he is losing weight and having more frequent and more painful urination. In two other cases the symptoms are about the same and the patient's general condition is slightly improved, but the carcinoma still persists. One of these was treated with radium about three months ago, and the other was treated several times, beginning in October, 1915. In two of the nine cases the growth has disappeared. One has only recently been cystoscoped, notwithstanding the radium was applied in February, 1916. In the other the growth has been absent (by cystoscopic examination) for three months. These last two cases are of enough interest to report in some detail.

Case 1. C. T. Age 59. Came to Dr. Keyes, January, 1916. Since June, 1915, occasional attacks of painless hematuria. In July, two bloody emissions, though impotent ten years. At that time a papilloma was found and since then has been fulgurated four times—October 22, November 1, December 9, and January 11. Because of the return of the growth, it is suspected to be carcinoma. Dr. Keyes reports a sloughy ulcer about the left ureteral orifice with definitely carcinomatous-looking lumps in the edge. A piece was removed which Dr. Ewing reports as diffuse carcinoma (Fig. 1), and the growth was burned again with the high frequency current. Three weeks later, 214 millicuries of screened radium were left in his bladder for seven hours. After the irradiation he went to his home and had various ups and downs, attack of grippe,

etc. Three days after the irradiation and for a period of two weeks, he arose five to six times at night to urinate but had no special burning on urination. From that time on the frequency has diminished. He was cystoscoped on May 2, 1916, at which time no trace of the original tumor could be detected. The entire bladder was slightly congested and there were a few bullæ about the bladder orifice. He is the picture of health, and there is no hardness felt in the prostate or the base of the bladder. I quote Dr. Keyes in saying "fulguration could never have done that."

Case 2. C. A. G. Sixty-nine years. History of painful and frequent urination for one year; 3 to 4 times at night, and by day every 3 to 4 hours. She has been passing bloody urine for some time. She was cystoscoped some months before I saw her and a diagnosis made of inoperable carcinoma of the bladder. Cystoscopy showed a large red cauliflower tumor with small necrotic areas on the left side of the bladder base. I had some difficulty in determining its full extent. It probably was as large as half a dollar and sessile. It was directly over the left ureteral orifice, which could not be seen. Dr. Ewing reports carcinoma (Fig. 2). I burned the tumor twice with high frequency current, but this had little or no effect upon it and I considered it useless to continue. On January 4, I put 100 millicuries of screened radium in her bladder and left it in eight hours. She went out of town the next day and at the end of three days had severe bladder pain with increased urinary frequency so that she urinated every hour. Two days later she was absolutely normal as to pain and urinary frequency.

On February 4, she was cystoscoped and the tumor was gone. The ureter was in plain sight and covered with normal mucous membrane. She had a little pedunculated papilloma of the bladder neck which was burned. Dr. Keyes confirmed my examination. She was recystoscoped April 28; still no

PLATE I—Presented by Dr. B. S. Barringer

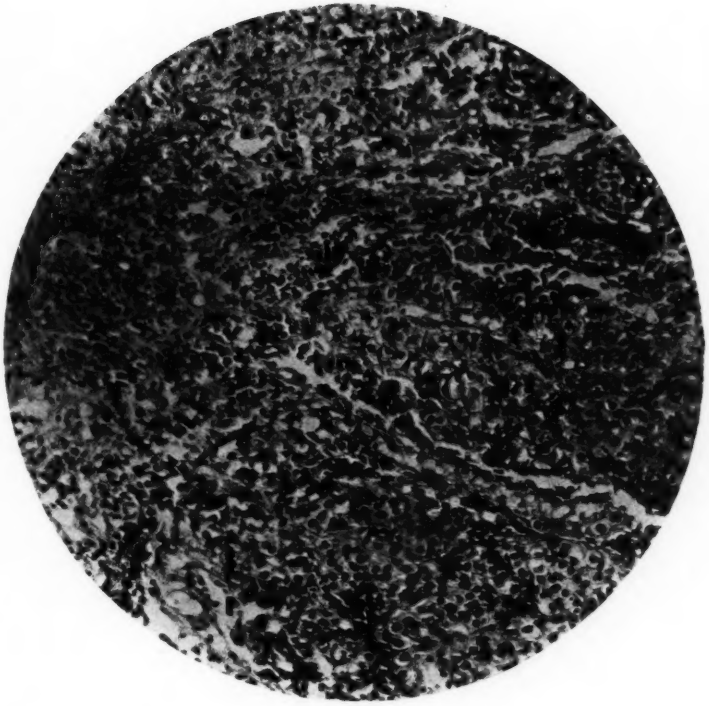

Fig. 1. (See page 31.)

tumor. She had a slight cystitis (caused by retention of urine due to a cystocele).

Whether the carcinoma in these cases will return or not, no one can say. I believe that the fact they have reacted so quickly to radium may indicate that we have eradicated the growth. Only time will tell, however.

Carcinoma of the Prostate

The problem involved in the diagnosis and treatment of carcinoma of the prostate is different from that of carcinoma of the bladder. In the first place is the difficulty in diagnosis. An extensive carcinoma which runs up into the vesicles can usually be exactly and positively diagnosed by palpation. On the other hand, a carcinoma as extensive as this is probably beyond the hope of cure. If the carcinoma, as far as can be determined by palpation, is confined to the limits of the prostate, then the diagnosis by palpation alone is sometimes not only difficult, but impossible.

In a recent case which I treated with radium there were two positive diagnoses, including my own, which was possibly biased, one of "very suspicious," one of merely "suspicious," and two indeterminate. As Geraghty has pointed out, palpation of the median lobe on a sound introduced into the urethra is of assistance. It has been suggested that enough of the prostate for microscopical diagnosis can be obtained by the introduction of a trocar through the perineum into the suspected prostate. In one of my cases part of a carcinomatous lobe was removed and the diagnosis made from this. Such a procedure, however, is not ideal, as it might make the carcinoma grow more rapidly. If one treats cases which he is sure are carcinomata of the prostate, but in which a microscopical diagnosis has not been made, and makes such cases temporarily or permanently better, one will, of course, run a risk of dealing with cases which were not carcinomatous.

Treatment. The operation after Legueu, Young and others apparently succeeds in curing the disease in a certain number of cases. The operative mortality is probably between 10 and 20%, and the cured cases very few. Aside from the mortality, one objection to the operation is the fact that many cases are left with partial or complete incontinence. Because the results of an operation are unsatisfactory, radium has been employed in attempts to destroy the growth. Irradiation has been both rectal and urethral. Pasteur and Degras (Radium in Cancer of the Prostate, Journal d'Urologie, September, 1913) report a number of cases in which the radium in the prostatic urethra or bladder gave a marked diminution of the size of the prostate and a decided improvement in symptoms. One case three and one-half years after treatment by radium was in excellent health with a small regular movable prostate and clear urine. This carcinoma had extended through into the bladder. Geraghty, applying radium by way of the urethra, has been able to relieve the symptoms of frequent urination, tenesmus, etc., in a number of cases, but has been unable to cause any appreciable diminution in the size of the carcinoma.

Technic of Application of Radium. Because the carcinoma starts in the interior of the prostate gland, and radium by urethra or rectum often causes intense irritation, I have applied the radium differently. A needle 4½ inches long and about 18 gage has been used. From 50 to 100 millicuries of radium have been placed in the end of this needle for a distance varying between ¾ of an inch and 1½ inches, according to the indications of the individual case. The patient is placed in a lithotomy position, a finger introduced into the rectum and the perineum between the urethra and rectum is anesthetized with novocain (1%). I have frequently inserted the needle without anesthetization, causing very little pain. The radium needle is then plunged into the perineum between the urethra and rectum, and, guided by the rectal finger, the end

PLATE II—Presented by Dr. B. S. Barringer

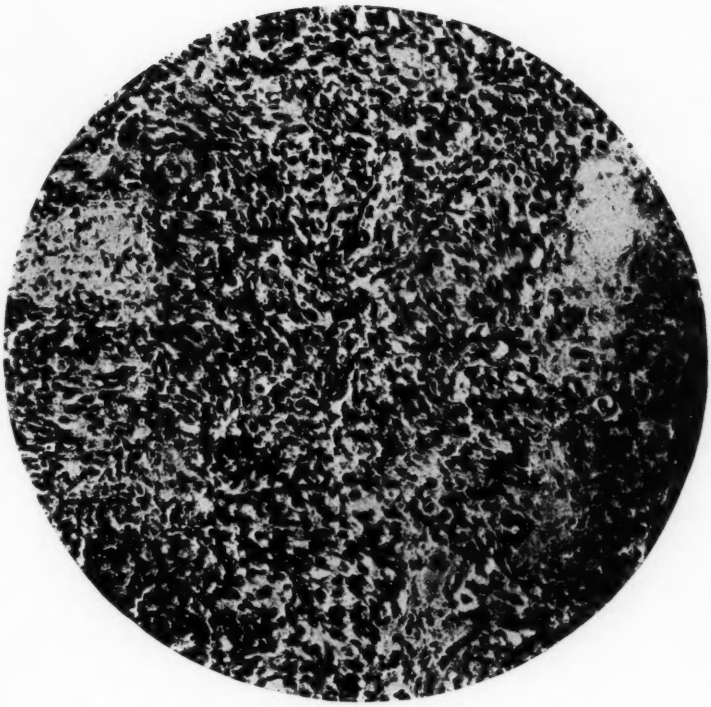

Fig. 2. (See page 32.)

of the needle is passed into the middle of one or the other of the carcinomatous lobes.[1] After the needle is introduced, the patient frequently does not feel its presence. The needle is left in place from four to six hours. If one wishes to irradiate the other lobe, the needle is pulled out of the first lobe and introduced into the second and left there the proper time. The ease of this procedure is obvious. I was nearly dissuaded from using this method by reports of necrosis following the use of unscreened radium. I have now used the needles in the prostate fifteen times and to date have gotten no radium sloughs. These patients are apt to have burning and pain beginning the week after the radium is used and lasting for from one to two weeks. During this time the prostate swells and the maximum effect of the radium on the growth is not to be looked for until two to three months. Some patients, notably those with the carcinoma extending into the vesicles, have a great deal of pain. Neither the pain, however, nor the urinary disturbance is as great as when the radium is used in the bladder. And curiously enough, radium in the urethra seems to cause or increase an already present residual urine; while this needle method, as far as I have observed, does not. There is a certain class of borderland cases in which the carcinoma has broken through into the bladder neck and in which it is a question whether to use the prostate needles or the screened radium in the bladder neck. I think these cases should be started with prostate needles as the reaction is often little or nothing.

Prostatic Carcinoma. Report of Cases.

Extent of Lesion. Five cases have been treated by the needle method.[2] In but one of these cases was a specimen obtained for pathological examination. In this case the blad-

[1] The needle in the prostate also serves to exclude prostatic stone, the one condition hard to differentiate from carcinoma.

[2] A sixth case was treated by radium inserted in the rectum. In this case there was considerable irritability, urinary retention and the patient finally died uremic. I have not included him in the above series.

der was opened suprapubically, one lobe of the prostate removed and found to be carcinomatous. In two of the cases there was very extensive carcinoma of the prostate with involvement of the vesicles. In another case there was but little involvement of the vesicles, but a large hard irregular unmistakable carcinomatous prostate. In the fifth case there was a doubt of the diagnosis. Dr. Keyes and I thought it to be carcinoma. Another surgeon said that it was "very suspicious," still another "suspicious," and two refused to give an opinion.

Number of Treatments. In one case I inserted the needle four different times, in the four other cases I used the needle only once. The largest dose of radium that I have used in a needle is 102 millicuries for 4½ hours in one lobe and the same needle was changed to the other lobe, and remained there 4 hours. I have never seen a slough from the use of the needle, although I prefer to begin with small doses at first, 50 to 75 millicuries for 6 hours.

Results of Treatment. One patient died two months after the irradiation. He had an extensive carcinoma of the prostate and vesicles. The immediate cause of his death I do not know. One of the patients has been too recently irradiated to determine the result. The three other cases have all improved symptomatically. One, who was irradiated in December, 1915, directly after suprapubic exploration (by another surgeon), I have been unable to reach to examine. I have heard indirectly, however, that he is up and doing a good day's work. This is all I know about him. The second, a possible borderland case, was treated February 8, 1916. He had just before the irradiation an acute retention of urine. For six months prior to this he had a night urinary frequency (2 to 4 times). The radium needle caused absolutely no pain and no urinary disturbance. When seen May 3, 1916, his prostate was considerably reduced in size (examination by Dr. Keyes and Dr. Barringer). He had gained a few pounds

in weight, he had no night frequency and was doing a full day's work. During this time he had no urethral instrumentation.

The last case is very decidedly better symptomatically, and his prostate is so much reduced that if I did not know his history I would have much difficulty in convincing myself that he had any carcinoma. He was first seen November, 1915. He gave a history of night urinary frequency of 6 to 8 times for four months, and some pain running down his right thigh for five years. No erections for 1½ years. Weight 116 pounds. He had lost some 20 pounds. Both lobes of his prostate were large, irregular, stony-hard (examination by Dr. Keyes and myself), slight extension up toward the vesicles. The prostate was so hard that the possibility of prostatic stones was thought of. A radiograph excluded this. He had no residual urine. Radium was used in November, 1915. A month later he reported that he had a number of vigorous erections which "gave him hope." The prostate at that time was at a maximum swelling. January 14, weight 126. Prostate is much reduced. Dr. Keyes says "it is more the slight irregularity of the prostate than anything else that suggests carcinoma."

I again irradiated him January 18. February 7, not up at all at night. Weight 132¾ pounds. February 22, irradiated again. April 4, irradiated once again. When last seen, April 21, his frequency had gone from none at all at night to twice at night because of the radium of April 4. He has a small hard lump in the left lobe and a narrow hard ridge along the outer margin of the right lobe. The prostate is very flat. This man has gained some 16 pounds in weight. From getting up at night 6 to 8 times, he has had a long period just before the last radium burn of getting up not at all at night. His prostate is very markedly reduced in size, but I believe still has carcinoma in it. For six months his carcinoma and the symptoms caused by it have markedly regressed.

Summary

By means of radium we have caused the rapid and complete disappearance of two bladder carcinomas out of nine treated. These cases were carcinomatous by cystoscopic appearance and microscopical examination. Time only will tell whether these are cured cases.

In one case of prostatic carcinoma treated for six months the carcinoma and the symptoms have markedly regressed. In another case, treated three months (possibly borderland), the symptoms have improved. Of three other cases treated, one is dead, one has only recently been treated, and one is doing a full day's work but could not be reached for examination.

DISCUSSION

Dr. Arthur L. Chute, Boston: I would like to put on record two cases that bear out Dr. Hagner's experience. The first was a man who had had a perineal prostatectomy and was practically healed when he began to bleed profusely. The usual mild methods of controlling intravesical hemorrhage were tried without result, and it became necessary to open his bladder suprapubically and pack it. As he still oozed, we used rabbit serum; but I have never felt sure that this exerted an influence on stopping his bleeding. The hemorrhage was evidently from the bladder outlet. We found that this patient had bled profusely once when he had a tooth drawn, also following an operation on his nose. He did not believe it would have any bearing on his prostatectomy, so had not mentioned it. He did perfectly well.

The other one was a man who had had a suprapubic operation; about two weeks after the operation he bled furiously and had to be packed repeatedly. He finally got well.

Both these men had some arteriosclerosis, but I do not know how high their blood pressure was.

Dr. James Pedersen, New York: May I ask Dr. Hagner whether in his two cases the men had been up out of bed before the hemorrhage occurred?

While it is desirable to get our elderly post-operative prostatics up out of bed, because of the risk of hypostatic congestion, etc., it would seem necessary in some cases to modify that rule and be satisfied with sitting them up in bed. It is possible that in these cases of long delayed secondary hemorrhage, the hemorrhage occurs as a result of getting the patients up on their feet too soon. Furthermore, a patient liable to high blood pressure should be safeguarded against that before he is allowed out of bed.

Referring to Dr. Barringer's technic for local anesthesia in prostatectomy: I understand that Dr. Barringer would limit it to patients in whom there is a contra-indication to the use of nitrous oxid gas.

Dr. Hugh Cabot, Boston: I would like to discuss Dr. Barringer's first paper on anesthetics. It is not clear to me precisely what indi-

cation—the question just raised by Dr. Pedersen—he regards as important there. That the use of local anesthesia in connection with these operations is valuable seems to me clear. I think it was the basis of our use of spinal anesthesia, and it has been the objection, on account of danger, to spinal anesthesia that has caused its abandonment for suprapubic operations. Now I have tried conscientiously in the last three years to kill some of these old fellows with gas and oxygen and I have had no luck, and I have grave doubts as to whether there is anything peculiar to those patients that renders gas and oxygen more dangerous than in other conditions. At the present time we use it exclusively as a general anesthetic for these patients, and it has seemed to us quite as safe as in the ordinary run of patients. Precisely what risk one should attach to gas and oxygen I am not clear. I am clear to this extent, except in the hands of a well-equipped expert it is a very dangerous anesthetic. We have killed two patients, without the slightest question, with gas and oxygen, both of them young patients in whom there was no contra-indication to gas and oxygen so far as we could see—both with damaged kidneys, but the deaths were not in any way related to the kidneys. On the other hand, those who have used most gas and oxygen are of the opinion, which I believe to be sound, when properly managed it is a comparatively safe anesthetic. I believe that ether is highly objectionable in these cases, and I am unwilling to use it. Our present procedure is a combination of Dr. Barringer's and the pure gas and oxygen. We use local infiltration of the bladder. We have not infiltrated the prostate, but I think it might be desirable. But, on the other hand, the objection to this infiltration is the duration. It does seem to me important to get this thing done and over with promptly. I have doubts as to whether a considerable lengthening of the operation is a wise procedure, though perhaps we have gone to the extreme of trying to do our operations too rapidly. There is a happy medium somewhere. If I should use Dr. Barringer's technic I should probably extend the time in the neighborhood of forty minutes, which seems to me to be too long. It seems to me desirable and possible to finish the majority of these operations in twenty to twenty-five minutes, and I think the margin of safety of these patients, as far as operations are concerned, is considerably less than in early life, and that the actual expenditure of time is an important element which

I think, to a certain extent, makes against the infiltration anesthesia as the method of election. It is not clear to me that there is any indication for this method not served by the combination of local and general, with the saving of time which can be had in that way.

Dr. Hagner teases me to say a word about the symptoms of the cases that died from nitrous oxid anesthesia. We have had three cases. I am concerned with them chiefly because I am chairman of the committee on anesthetics at the hospital and all deaths have to be carefully looked over. We have been fortunate in being able to get a complete post-mortem examination in these cases, because we have made them medico-legal; we have declared that they died of violence. The deaths are like chloroform deaths; they stop absolutely and there is not a kick in them. Nothing that you do to them has any effect. All of them have been cases that were more or less cyanotic, which Crile has frankly said means that the anesthetic is not properly managed. They were all cases in which I was concerned with the anesthesia, though it was supposed to be none of my business, as they were in the hands of an experienced anesthetist. They were all considerably cyanotic from the beginning of the anesthesia; then, without warning, everything stopped, bang! and nothing would start them. I believe it to be a toxic death. They behaved exactly like chloroform deaths, except in not being white; they were slightly cyanotic.

Dr. A. C. Wood, Philadelphia: I have just a word to say on the subject of the use of anesthesia in prostatectomy. I think Dr. Cabot's statement that the contra-indications to the administration of ether or of any other anesthetic depend largely upon the skill of the anesthetizer, is perfectly true. Given carefully, nitrous oxid and oxygen gives us an anesthesia that is very nearly ideal as regards both safety to the patient and satisfaction to the operator, but I consider it a much more dangerous anesthetic in careless hands than ether. When a general anesthetic has seemed to me to be contra-indicated—and I do not know that I can give any absolute contra-indications; it is a matter of experience and of personal opinion that each operator must decide for himself,—I have been very much pleased with the effect of morphin and scopolamin, or morphin and hyoscin, which is said to be the same thing. I have, in a few cases, following one dose of morphin, gr. ¼, and scopolamin, gr. 1/100, given hypodermatically,

been able to do a suprapubic prostatectomy without any pain or discomfort to the patient and with perfect satisfaction to myself. In the cases in which it has been used the convalescence was rapid and the recovery complete. Like any other method, much depends upon the operator's preference. Some do not object to operate on a patient fully conscious, others prefer an unconscious patient. My own preference is to have the patient unconscious, as I believe in any large series of cases the technical details would be better carried out on the average, and it is certainly desirable, in many cases, that the patient be spared the mental effect that a knowledge of the operation might produce.

Dr. Geo. W. Warren, New York: In the discussion of Dr. Barringer's second paper I should like to present some microphotographs of sections made from specimens of bladder tumors obtained by resection.

This first microphotograph was taken from a section of a tumor which appeared cystoscopically to be an ordinary papilloma of the bladder. The photograph is of a section by low power embracing both the tumor and the bladder wall. The second microphotograph is taken under high power of an area in the bladder wall. This section, as you will see, is undoubtedly malignant and by referring to the low power section is seen to be from a point nearly through the bladder wall. This case, to my mind, could be treated only by surgical means. These other microphotographs merely substantiate the points already made.

I again wish to call attention to the value of developing a surgical technic in the treatment of bladder tumors. In the past year our cases have been more successfully operated upon by the use of the clamp exhibited last meeting and following the technic which I advocated at that time.

Dr. John T. Geraghty, Baltimore: I would like to discuss Dr. Barringer's second paper. In the beginning our experience with radium was in connection with Dr. Kelly. We sent a series of cases for radiation with massive doses, having the radium applied over the suprapubic region or perineum. These cases would receive from fifty thousand to two hundred thousand milligram-hours per treatment. Most of them seemed to improve symptomatically and many, having complete retention beforehand, began to void voluntarily again;

the pain decreased and most of them were made quite comfortable. But notwithstanding this symptomatic improvement, there seemed to be no change at all in the prostate, the size and induration remaining the same.

We had an opportunity to study one of these cases that had received a hundred thousand milligram-hours; several months after the treatments had ceased, he died suddenly of a cardiac condition and the autopsy showed no change at all in the cancer. It was a typical carcinoma, although on high magnification, some slight changes were noted in the cells.

The almost negative results obtained following the external application of large doses would seem to be accounted for by the fact that the radium had been placed at too great a distance from the prostate. The effect of radium varies inversely as the square of the distance and a hundred milligrams at one centimeter has exactly the same effect as twenty-two and one-half grams at fifteen centimeters. Realizing this fact, we used it in the urethra and our symptomatic results were a little more rapid but the prostate showed very little change. We then began to apply it per rectum, believing that this would be an ideal portal for radiation of the prostate and seminal vesicles because of the intimate anatomical relationship. The experience of other observers, however, had shown that severe local reactions had frequently followed the use of large doses of radium per rectum. We were very cautious, therefore, in the beginning, using but one hundred milligrams which was always so screened that only the gamma rays were available, and applying it for short periods of time with frequent change of position. The time of radiation at a given point was gradually increased but has rarely exceeded one and one-half hours during any one treatment. During the next three or four applications other points are treated, no one point being radiated on successive days. In this way we have thus far been able to avoid any serious rectal irritation, although in some cases which have received from fifteen hundred to two thousand milligram-hours, rather marked edema of the mucosa has been noted, but in no case has the process gone on to actual ulceration. The condition has not been associated with any pain but in practically all of the cases a mucous discharge has been present. Digital examination shows considerable thickening of the rectal wall and in some cases it has been so marked

as to render the outlines of the prostate indistinct. When this occurs it is wise to suspend all treatment for one or two months, in which time the edema and discharge have usually disappeared.

It is advisable, therefore, to give the treatment in series. From fifteen hundred to two thousand milligram-hours are given in the course of five or six weeks, at the end of which time the local reaction is often such as to call for a cessation of treatment, which is not renewed until the condition has subsided. In cases presenting symptoms of urinary obstruction, relief has frequently followed four or five hundred milligram-hours of radium applied to the region of the vesical neck, but the large proportion of the treatment is given per rectum, the results of urethral radiation being almost entirely symptomatic. It is well to emphasize the fact that in carrying out the treatments per rectum, the local reaction may be postponed if care is used in the selection of points for radiation. At the time of the first examination, a chart is usually made and the positions of the future treatments outlined. In cases having a bilateral involvement of the prostate and seminal vesicles, there are at least eight possible points to which the application can be made. Thus the position of the radium changes with successive treatments, the radiation of any given point never being repeated until the other possibilities are exhausted.

It is too early as yet to draw any definite conclusions regarding the ultimate results of this treatment. Practically all of the cases treated thus far have been extensive, not only the prostate but the seminal vesicles being involved. The large majority have responded symptomatically and nearly all of the cases receiving rectal radiation have shown more or less change in the prostate itself. In three cases having extensive involvement of the prostate and seminal vesicles —cases in which the diagnosis was certain—the change in the size and induration of the prostate has been most striking and, on examining these cases for the first time, one would not be the least bit suspicious of carcinoma.

As regards bladder tumors, our experience is probably a little greater, because we began to treat these cases directly from the beginning. As the treatment of these tumors varies with the different types, we have divided them arbitrarily into benign papillomata, malignant papillomata and papillary carcinomata and the rarer group

of adeno-carcinomata, scirrhus, squamous celled, etc. It is well to separate this latter group of cases from the papillary carcinoma in which transplantation of cells may follow the slightest trauma. In the other type, there is little danger of transplantation and the tumors may be handled as carcinoma in other regions.

Now I realize that there is no difference histologically between a malignant papilloma and a papillary carcinoma; they are both cancer and both give rise to metastasis. When the malignant papilloma infiltrates the bladder wall we call it a papillary carcinoma. We made it a practise for a number of years to remove small pieces of tumor, believing that by microscopic study we could determine some form of treatment which would be rational for that particular type. Unfortunately, however, the histology of the two tumors is the same and the cystoscopic examination will determine largely the treatment applicable in a given case. The response of the two tumors to high frequency may also be a means of differentiating them; fulguration may remove the malignant papilloma but it has no effect on papillary carcinoma.

We have used radium in a few cases of benign papilloma with very satisfactory results, the tumors disappearing rapidly. In three cases of malignant papilloma which had failed to respond to fulguration, six hundred milligram-hours of radium was employed in each case during a period of some weeks. On returning to fulguration the tumors completely disappeared in one or two treatments, responding like typical benign papillomata. We are now using, therefore, the combined method. We radiate the malignant papilloma, using both the beta and gamma rays, for four or five hours (100 mgm.), after which the tumors rapidly respond to fulgurations.

As far as papillary carcinoma and the other types of cancer are concerned, we have been unable to cure any of them. Probably we have not used enough radium. At any rate, until our technic of handling these cases improves, it would seem that where the tumor can be completely excised, operation is the preferable treatment.

Dr. Barringer (closing): In answering the queries about the first paper, my object was simply to start out and see if I could do prostatectomy under local anesthesia. I, at that time also, feared the length of the operation, which took about forty minutes—but

the length of operation apparently did not seem to have any effect in causing added shock.

I entirely agree with Dr. Cabot that if you have an expert in the use of gas and oxygen it is proper to use this anesthesia, but in one of my cases I did the prostatectomy in a hospital in the country, went there, operated, and never saw the patient again. In that case I think it was an excellent anesthetic to use, because of the lack of any gas-oxygen expert.

Just a word about the use of radium in the rectum. In one case of prostatic carcinoma I saw radium used in the rectum by a physician who was much more expert than I in the use of radium. This patient got up a good deal of rectal tenesmus, retention of urine and died of either uremia or radium, I do not know which; I always suspected it was radium. From that time I have always refused to use radium in the rectum. I did not like the results.

Dr. Hagner (closing): We have been using nitrous oxid in these cases, having an expert give it, and the results have been very good; we have lost none of these cases. But we did lose a patient with carcinoma of the bladder who insisted on having an anesthetic for a cystoscopic examination. He had had nitrous oxid a few months before. As soon as he took the nitrous oxid his breathing was shallow but pulse good. Three minutes after the anesthetic was stopped, he died, acting just the way Dr. Cabot described.

I believe these cases of hemorrhage are due to high blood pressure. It seems to me that is the most rational explanation of them. These cases were up and walking around the rooms, but we have many others walking around the rooms that do not bleed. We had a patient about a year and a half ago that was brought to the hospital with a violent hemorrhage of the bladder. The man had an enormous prostate. The doctor was working on him when I got there. He had lost a good deal of blood from the appearance of the room. I tried to wash his bladder out. The bleeding continued, and I suggested that we open the bladder. His blood pressure was very high. While we were waiting for the anesthetist to come this patient had a stroke of apoplexy. He was afterwards operated upon, the prostate removed and he recovered.

CYSTOGRAPHY

ITS VALUE AND LIMITATIONS IN SURGERY OF THE BLADDER

By Herman L. Kretschmer, M.D., of Chicago

ALTHOUGH cystography can be more easily carried out than pyelography, nevertheless it is interesting to note that this method of diagnosis has not received as much detailed study as has pyelography, so that its possibilities have not been determined, and its limitations established, to the same extent that they have been in pyelography. One of the reasons that cystography has lagged behind pyelography, is due to the fact that cystoscopic examination usually gives the desired information regarding intravesical lesions without resorting to cystography, except perhaps in a certain small percentage of cases, whereas pyelography is sometimes necessary to supplement the knowledge gained from cystoscopy and ureteral catheterization.

In carrying out this work, cargentos in 20% solution, emulsion of silver iodide, and 10% solution of thorium nitrate were used. Except in the earlier cases, thorium nitrate was used as a routine. The cargentos has given us extremely satisfactory pictures without any signs of irritation or pain; the only objection to its use is its staining properties. The patients in whom the silver iodide was used complained of severe pain, and a great deal of vesical tenesmus. In some instances several cystographs were taken at intervals, and each time the patients complained of pain and irritation in the bladder. The thorium nitrate was made up for us by Mr. Gray, Pharmacist of the Presbyterian Hospital, according to the formula of Burns of Johns Hopkins.

The normal bladder in adults has been carefully studied by this method so that our knowledge of a normal cystograph is fairly well established.

This method has contributed very largely toward settling the dispute about the vesical neck. For many years discussion swayed between various schools of Genito-Urinary Surgeons, as to the rôle played by the posterior urethra and vesical neck in bladder closure. The studies on this topic have resulted in practically unanimous views so that all agree that the internal sphincter causes vesical closure and that no funnel or neck of the bladder is formed by the posterior urethra. Attempts to prove that the posterior urethra takes part in forming the vesical neck when the bladder is much distended, were published by Oppenheim and Löw. Their findings, however, have not been corroborated by other workers, as far as I know. The illustrations presented by them lead one to the inference that they were pear-shaped bladders. They carried out this work in *monkeys*.

The normal cases in this series *did not* show this phenomenon. There was always a very sharp demarcation at the vesical neck, even in the cases in which there was a good deal of straining, and in which the urethra was filled with the thorium solution.

The contention that the posterior urethra does not take part in forming a vesical neck was strongly championed for many years by v. Zeissl, of Vienna. He set about to demonstrate graphically his views. To accomplish this he introduced mercury into the bladders of two cadavers, and then filled the bladder with a fluid impermeable to Roentgen Rays. From his Roentgenograms he comes to the conclusion that the posterior urethra does not form the bladder neck. One of his reproductions shows the sharp demarcation between the urethra and bladder. These experiments, although carried out in cadavers, were the first cystographs taken, and were published in 1902.

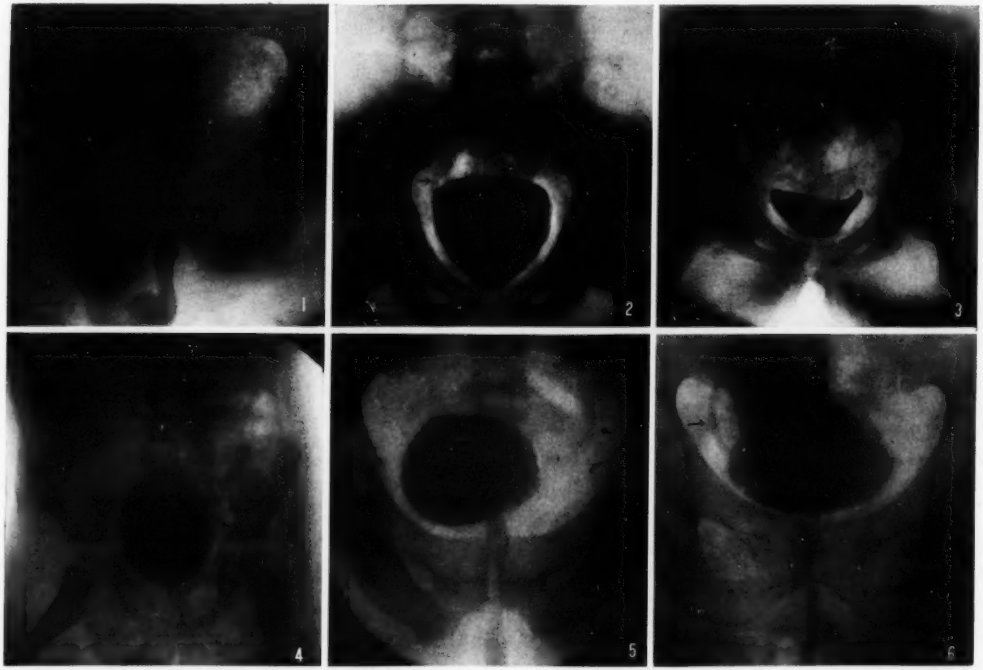

PLATE III—Presented by Dr. H. L. Kretschmer

Fig. 1. Complete displacement of entire bladder due to infection in the space of Retzius. Note the neck of the bladder and filled urethra. Fig. 2. Pyriform bladder. Note the regurgitation of fluid into ureter. Fig. 3. Note peculiar shape of bladder, also regurgitation of the silver iodide into the ureter. Fig. 4. Oval bladder. Note regurgitation of fluid up the ureter and into the renal pelvis. Fig. 5. Regurgitation of fluid into the left ureter, in normal bladder. Displacement of bladder to right. Sharp demarcation between urethra and vesical neck. Fig. 6. Benign hypertrophy of prostate. Regurgitation of fluid into the left ureter. Note dumb-bell shaped bladder.

In Fig. 1 a resemblance to a vesical neck is seen. This was a pathological case, the patient (age 16) suffering with an infection in the space of Retzius: this was opened and drained. The funnel-shaped neck shows irregular margins. Unfortunately a second Roentgenogram was not made. In view of the pathology it would have been interesting to have taken a second picture after voiding, to determine whether this shadow disappeared, or whether it persisted, due to the presence of fluid outside of the posterior urethra. (See Plate III.)

The Bladder in Children

In order to demonstrate any possible differences that may exist as far as the shape of the bladder is concerned, between the bladders of infants and adults, a series of Roentgenograms were made in children. In none of these infants' bladders were we able to demonstrate any different condition in the vesical neck, as far as an encroachment of the urethra on to the bladder is concerned, from that seen in adults.

The ten cases studied were free from disease of the urinary organs, and they were patients that had been admitted to the Children's Memorial Hospital for diseases other than urinary. Of the ten bladders, six were distinctly pyriform with the apex situated at the vesical neck and the base of the pyramid above (Fig. 2). Of these six pyriform bladders, three were boys and three were girls. Their ages varied from three to ten years. There was no difference in the shape of these bladders between the girls and boys.

In three the bladders were oval from right to left. One case had an unusually shaped bladder, so that the top was concave (Fig. 3). One would be inclined to explain this defect of distention as being due to some intra-abdominal cause (bowel?), or perhaps this may have been due to insufficient distention.

Regurgitation of Fluid Into the Ureter

Normally the uretero-vesical junction or valve is supposed to prevent a reflux of fluid from the bladder up the ureter and into the kidney. Failure of this mechanism becomes of serious moment, especially in cases in which the bladder is the seat of infection, inasmuch as infection may be directly transmitted upward into the higher urinary tract.

While I believe that this method of renal infection is not the only possible route of infection, I do believe that infection does not occur nearly as frequently in this way as was formerly taught. Modern views favor the lymphatic origin of renal infection and the urogenic route is being more and more tabooed. Yet it is significant that in ten normal children this phenomenon occurred three times. The accompanying Roentgenograms of these normal cases, as well as the pathological cases, demonstrate that this mode of infection is possible.

For the purposes of study, the cases in which reflux occurred have been placed into two groups, normal and pathological.

In children this phenomenon occurred four times in eleven cases examined. Three times in infants in whom the urinary tract was normal, and once in an infant suffering from colon cystitis and pyelitis (Fig. 4). All of the cases were examined in the same way, and under the same conditions. It is rather striking, therefore, to see the frequency with which it was possible to demonstrate regurgitation of fluid into the ureter in children. As far as I know, this is the first time that regurgitation of fluid into the ureter has been demonstrated in children with normal bladders. In these cases examinations were carried out under ether anesthesia. In each of the four cases the regurgitation was unilateral.

In one of the adults in whom this regurgitation occurred the bladder was perfectly normal, and the ureteral orifices

Fig. 7. Contracture of vesical neck. Regurgitation of fluid into ureter. Fig. 8. Tuberculosis of kidney and bladder. Regurgitation of fluid into *both* kidneys. Fig. 9. Interference with complete distention of the bladder due to a pelvic abscess. Fig. 10. Filling defect due to pressure from without. Parametritis. Note also double shadow above. Fig. 11. Filling defect of bladder due to pressure from without. Fibroid of uterus. Fig. 12. Filling defect caused by enormous carcinoma of uterus.

appeared normal upon cystoscopic examination (Fig. 5). During the Roentgen examination, the patient had a great desire to urinate, so that he strained a good deal. The Roentgenogram shows regurgitation on the left side. Just why this occurred only on the left side is difficult to explain. It would seem logical to explain this regurgitation as being due to increased intra-vesical pressure, incident to his straining. A subsequent cystograph, made without straining, showed a normal bladder without regurgitation.

In five adult cases in whom this regurgitation occurred there were associated lesions of the urinary bladder. The following diagnoses were made:

1. Benign hypertrophy of the prostate (Fig. 6).
2. Contracture of the vesical neck (Fig. 7, Plate IV).
3. Tuberculosis of the bladder, prostate and vesicles (Fig. 8).
4. Tumor of the bladder, chronic retention.
5. In the fifth case no definite diagnosis was made.

In the first three cases cystoscopic examination showed normal-appearing ureters. In two cases the ureters were dilated, as revealed by cystoscopic examination. In the three cases in which the ureters appeared normal, there occurred during examination a great deal of tenesmus and straining, so that it became necessary to compress the urethra between the fingers in order to retain the fluid in the bladder, so that the Roentgenogram could be obtained.

The cystoscopic examination does not always give information relative to whether the ureter is dilated or not. The ureter at autopsy may be found very much dilated, although previous cystoscopic examination revealed a normal ureteral orifice. This is precisely what occurred in some of these cases, cystoscopic examination revealing a normal ureteral orifice, and cystography demonstrated that the uretero-vesical valve was insufficient and the ureter dilated.

In the two cases in which the ureters appeared dilated there was no apparent increased intra-vesical pressure; both had atonic bladders. In this connection it is significant that there were a great many cases in which there was an increased intra-vesical pressure, yet no regurgitation took place. It would seem that the increased intra-vesical pressure may be at least partly responsible, in some of the cases, for the occurrence of this phenomenon.

Zuckerkandl noted this occurrence in some of his prostatic cases. I do not recall, however, of having seen reports of its occurrence in normal bladders with normal ureteral openings, nor are cases reported of the occurrence of this phenomena in children with normal urinary organs.

Displacements of the Bladder

Complete displacement of the entire bladder is not possible because of the fixed position of the trigone. That the movable part of the bladder may be displaced as a whole, is quite possible, and this occurred in two patients. In one patient the entire bladder appears displaced to the right (Fig. 5). Close examination shows the urethra filled with fluid. One week after this Roentgenogram was obtained, a second cystograph was made, which gave a normal picture. Curiously enough, this patient is one of the cases in which there was a regurgitation of fluid into the ureter. This patient was cystoscoped and the bladder and ureteral orifices appeared normal.

In case two (age 16) (Fig. 1.) a diagnosis of infection in the space of Retzius had been made, which I verified by operation. The patient had a slight amount of difficulty in micturition and the urine was negative. As a result of the pus infection outside of the bladder, the entire bladder appears to be displaced to one side, while still retaining almost completely its normal outline.

PLATE V—Presented by Dr. H. L. Kretschmer

Fig. 13. Cystoscopy showed a normal bladder. Note darker part of bladder in the right half and light area to left. Fig. 14. Note accessory shadow at apex of bladder. Fig. 15. Prostatic hypertrophy. Note absence of broad base. Diverticula of the bladder. Fig. 16. Extensive diverticula. Fig. 17. Diverticula of the bladder. Contracture of the vesical neck (?). Fig. 18. Prostatic hypertrophy showing broad base.

Change in the Shape of the Bladder Due to Pelvic Infection

That the presence of pus in the pelvis may interfere with the complete filling of the bladder, so that its outline presents deviations from the normal, is seen in Fig. 9. This patient suffered from urethral stricture for many years. Upon examination a large pelvic abscess could easily be demonstrated by bimanual palpation with one finger in the rectum. The cystograph revealed a filling defect on the right side, so that it presented a distinctly pathological outline. The margin is very irregular; this irregularity I believe is due to the presence of small sacculations. These, doubtless, are due to his urethral strictures. In one or two places the sacculations are quite large. Somewhat similar sacculations of the margin were noted in a case of bladder disturbances due to tabes.

Filling Defects Due to Associated Lesions of the Pelvic Organs in Women

Filling defects in the bladder may be due to a variety of causes: first, lesions outside of the bladder preventing a complete filling, so that the normal outline of the bladder is not obtained. Second, lesions of the bladder wall,—these may be limited to a part of the bladder wall, such as that seen in tumors, so that an incomplete filling results. Third, filling defects may be due to insufficient filling of the bladder. Great care must be exercised in interpreting these filling defects, because of the variety of causes that may produce them. That wrong conclusions and necessarily wrong diagnoses must ensue if each filling defect is to be ascribed to lesions within the bladder or bladder wall, is obvious, and is illustrated by the filling defects that were obtained in this series of cases due to various lesions in the pelvic organs of women.

It is easy to see how this error might be made if cystography alone is used. This group of cases furthermore demonstrates that cystography should be used supplementary to cystoscopy, and *not instead of it.*

Urinary symptoms due to pelvic lesions in women are not uncommon. Not infrequently pus is also found in the urine, and the conclusion is often reached that the lesion must be urinary in character. It is in this group of cases that cystography may lead to a wrong diagnosis unless other methods of diagnosis are resorted to. The filling defects as demonstrated in some of the cystographs obtained in cases of parametritis (Fig. 10) in no way differ from the defects seen in some cases of primary carcinoma of the bladder. Fig. 11 shows a filling defect due to an enormous fibroid. There was an associated colon bacillus pyelitis present. Fig. 12 shows the defect caused by an enormous carcinoma of the uterus, involving the bladder. The similarity of these filling defects to the defects met with in certain primary carcinomata of the bladder is apparent when the cystographs of each are compared.

Accessory Shadows

In three cases in which there was some irregularity in the cystograph, it was thought desirable to discuss in a group by themselves. In Fig. 13 there is an apparent different density of the shadow; the darker part being found on the right side and in general resembles those obtained in fibroid, or in some carcinomata of the bladder. The second or lighter area extends to the left side. The first impression is that one is dealing with a double bladder, or that this picture is due to some intra-vesical lesion. This, however, can be excluded, as cystoscopy was negative. Pelvic examination was negative, so that the bladder and generative organs were normal. It would seem reasonable, therefore, to attribute this phenomenon to an invagination of the bladder by a full bowel.

PLATE VI—Presented by Dr. H. L. Kretschmer

Fig. 19. Benign hypertrophy of prostate. Small contracted hour glass (?) bladder. Fig. 20. Benign hypertrophy of prostate. Large capacity. Absence of broad base usually found in benign hypertrophy. Fig. 21. Small fibrous prostate, causing complete retention. Elongated bladder. No broadening of base. Fig. 22. Carcinoma of prostate. Shows extensive broadening of base. Fig. 23. Primary carcinoma of prostate. Fig. 24. Carcinoma of prostate.

A second case showed what might be termed an extra shadow, sitting as it were on top of the bladder shadow (Fig. 14). This is less dense than the rest of the shadow. The patient had had a suprapubic operation, as well as several fulgurations for tumors, multiple papillomata. When this cystograph was taken his bladder was normal.

The third case occurred in a carcinoma of the bladder (Fig. 31, Plate VIII).

Diverticulæ

Although diverticulæ can generally be recognized by the cystoscope, it does not give one any accurate idea regarding the extent of each diverticulum. In cases in which the extent, often also the number, of diverticulæ are to be demonstrated, cystography offers the best single method at our command. That Roentgen Rays were a desirable method of diagnosis in these cases was recognized in 1904-5 by Kellar, who distended the bladder with air. In instances in which the diverticulum may be situated between the bladder and the rectum, its shadow may be obscured by the dense bladder shadow, hence the necessity of examining the patients with fluoroscope prior to taking the Roentgenograms, which had better be taken at several angles. The cystographs show the different sizes, shapes and positions of the diverticulæ. In two of the three cases the general contour of the bladder has been lost, due to the size, shape and positions of the diverticulæ. In Fig. 15, the bladder has fairly retained its shape; and the diverticulæ appear as appendages of the bladder. Doubtless cystography will often give one a better idea of the diverticulæ than will cystoscopy, and doubtless its one big value lies in this group of cases.

Changes Caused by Lesions of the Prostate

Benign hypertrophy of the prostate, and the resulting changes in the bladder have been subjected to this mode of examination and fairly constant cystographs have been obtained. The cystograph in these cases generally shows a broadening or widening of the base, so that the pear-shaped or spherical-shaped bladder becomes very broad with the narrow part placed upward, being just the opposite of the pyriform bladder (Fig. 18, Plate V).

In some cases the enlarged gland seems to elevate the bladder so that it is carried away from the symphysis. The two changes have been recorded frequently, and are put down as bladder changes due to the benign hypertrophy.

While in most of the cases examined pictures such as those just described have been obtained, in some of the Roentgenograms pictures were obtained that deviated slightly from those just described (Fig. 19). There is no broadening of the base. The upper part of the bladder is smaller than the base, and between these two can be seen a narrowing, so that a remote resemblance to an hour-glass was seen. From this cystograph one could not have made a diagnosis of benign hypertrophy. In Fig. 20 there is no resemblance to a broad base. The bladder is very large (500 c.c.). Its margin is very irregular, due to small diverticulæ formation.

In one case of a small, hard, fibrous prostate, an elongated picture was obtained, just the opposite of that usually seen in hypertrophy (Fig. 21). This picture very closely resembled that obtained in a case of chronic prostatitis, so that from the cystograph alone it would have been impossible to have made an accurate or differential diagnosis. When a typical cystograph is obtained, a diagnosis of prostatic hypertrophy may be ventured. Failure to obtain such a cystograph does not necessarily exclude benign hypertrophy.

PLATE VII—Presented by Dr. H. L. Kretschmer

Fig. 25. Cystograph after extensive resection of bladder for carcinoma (female). Fig. 26. Same as Fig. 25, four months later. Fig. 27. Carcinoma of bladder. Note filling defect above. Broad base as seen in benign hypertrophy. Fig. 28. Large epithelioma of bladder, female. Fig. 29. Carcinoma of bladder. Carcinoma situated in apex of bladder. Note filling defect. Fig. 30. Cancer of bladder. Note light center and dark periphery.

In carcinoma of the prostate nothing in the way of typical uniform Roentgenograms were obtained. In one (Fig. 22), a very extensive broadening of the base of the bladder was demonstrated. There was nothing by which this could be differentiated from a benign hypertrophy. Another cancer of the prostate showed a broad base with an elevation of the base (Fig. 23). There was also a slight defect in distention. In one of the cases the bladder was very much contracted, so that a very small amount of fluid was introduced. The small Roentgenogram, however, showed a broad base (Fig. 24).

Tumors

In rare instances it may be impossible to carry out a satisfactory cystoscopic examination, so that the size, location or nature of the tumor cannot be determined. It is in such instances that one would welcome some adjunct to our present diagnostic methods, provided it were reliable and did not have too many possibilities of misinterpretation.

A. Papillomata—For example, in papillomata that are undergoing or have undergone malignant changes at the base: in these tumors the part growing into the bladder may have the usual cystoscopic appearance of a benign papilloma, yet the base may have undergone malignant change. If this malignant change should extend into the muscularis so that a lack of distention is present and we are able to demonstrate this by cystography, then this might aid in simplifying the question of benignancy or malignancy. If this defect has been definitely established, one would perhaps consider resection or radium treatment, instead of resorting to fulguration, or perhaps a combination of the latter two, that is, radium and fulguration. On the other hand, this method may fail to give this information. In one case of *supposedly* benign papilloma, a normal cystograph was obtained. Histological exam-

ination revealed extensive carcinomatous changes in the tumor, and as just mentioned a normal cystograph was obtained.

B. In the carcinomata our results have shown three distinct phenomenon. These changes were: (1) a defect of distention, and (2) a variation in the density, although the outline was normal; (3) a diminished bladder capacity, so that a very small bladder picture was obtained.

The filling defect occurred in carcinomata irrespective of their size. The larger carcinoma did not show this filling defect, but presented a light, more or less mottled center. These might be suggestive of papillary carcinomata growing into the bladder, but not invading the bladder wall (Figs. 25, 26, 27, 28, 29, 30 on Plate VII, and 31 and 32 on Plate VIII).

Normal cystographs were obtained in the cases of abscess of the prostate in whom cystography was carried out. In one case of prostatic calculi, this method gave us no additional information to that obtained by a plain Roentgenogram.

In a case of chronic prostatitis, an oval bladder was demonstrated that closely resembled a cystograph obtained in a case of small, fibrous prostate with complete retention (Fig. 33). A differentiation from the cystographs alone was impossible.

Conclusions

1. Cystography is a valuable adjunct to our present diagnostic methods.
2. Cystography will always have a limited field of usefulness.
3. Great care must be exercised in interpreting the cystographs.
4. Because of its limitations and possibilities of misinterpretation, it can never hope to take the place of cystoscopic examination, but should be used as an adjunct to it and not instead of it.

PLATE VIII—Presented by Dr. H. L. Kretschmer

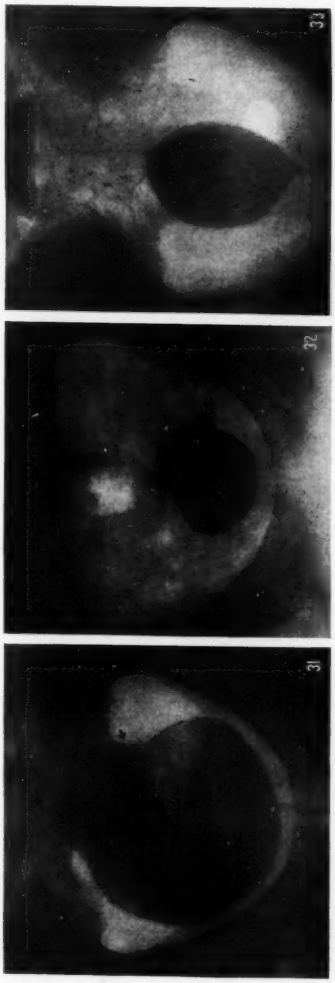

Fig. 31. Cancer of the bladder. Note the light mottled area corresponding to the tumor. An irregular shadow at apex. Fig. 32. Extensive carcinoma of the bladder. Extension from carcinoma of the uterus. Fig. 33. Chronic prostatitis.

5. It may be of aid in determining whether resection or fulguration should be employed in a certain percentage of papillary tumors.

6. For outlining the number, size and position of diverticulæ, it is easily the method of choice.

7. That regurgitation of fluid from the bladder into the ureter is possible in normal individuals has been demonstrated in some of the cases embraced in this report.

8. It has also been possible to demonstrate a regurgitation of fluid from the bladder into the ureter, in the presence of bladder infection, although the ureteral orifice appeared normal.

A STUDY OF EXSTROPHY OF THE BLADDER, WITH REPORT OF A CASE FIVE YEARS AFTER IMPLANTATION OF THE URETERS INTO THE RECTUM

By A. R. Stevens, M.D., of New York

EXSTROPHY of the bladder is one of the most distressing afflictions surgeons are called upon to treat. Fortunately it is a relatively rare malformation. Its incidence is given variously from 1 in 100,000 births [1] to 4 in 116,500 births.[2] It occurs in 7 boys to 1 girl.[3]

The embryological explanation, whether it be "rupture of the urogenital part of the cloacal membrane cephalad to the genital tubercle,"[4] "abnormal distention of the allantois and urinary tract" and consequent rupture,[5] or failure of the bladder walls to unite,[5] does not concern us here. The present study will discuss the principles involved in successful surgical treatment, and the relative merits of the types of operations which have been suggested.

The long list of measures suggested for exstrophy of the bladder implies at once that no one is adequate. Many types of treatment, and many modifications of these types, have been tried. Some of them can be dismissed with mere mention, as obviously failing to serve. There is a preponderance of failures over successes among unreported cases, and hence from published reports is obtained the relative value of methods rather than their absolute worth. Moreover, any one surgeon sees but an occasional case, and rarely is one permitted to compare different modes of treatment in personal experience.

Exstrophy of the bladder may be partial or complete, is always associated with complete epispadias, with partly bifid scrotum and with separation of the pubic bones. The distance between the pubic bones may be as much as 10 cm.[6] Probably the prostate and seminal vesicles are always present, as are the testicles. The sphincter ani is sometimes weak, and Stefanesco-Galatzi[7] reports a case with absence of this muscle. Urine trickles constantly from the open bladder, which early becomes infected and very tender. The pubic bones are held together by a fibrous band (some deny this as a constant condition[8]), and station and locomotion are satisfactory. The conditions to be dealt with are the tender and suppurating bladder, incontinence of urine with the ever-present urinous odor, and the possibility of renal infection.

Control of the last two conditions presents the difficult problem—one intimately associated with the general topic of ascending infections. In 1903, Sampson[9] systematically considered all the possible channels for an ascending urinary infection, and showed the lymphatic system to be the most common one. Referring to the effect of injury to the ureteral orifice, he recognized that "something additional is usually necessary" for an ascending infection. Draper and Braash[10] concluded tentatively that in the human subject ureteral meatotomy alone was harmless; but Barber and Draper[11] in experimental work found the normal ureteral orifice an important factor in preventing the passage of infection from the bladder to the kidneys in dogs, in which the blood and nerve supply of the ureter had been destroyed. Also, Sampson concluded that in human beings, ascending infection was found only with disease or injury of the ureteral orifice. More recently, Sweet and Stewart,[12] by a series of ingenious experiments involving anastomosis of the ureters with the bowel of dogs, proved in a convincing manner that the lymphatics are the route traveled by an ascending renal infection. They support this conclusion on the clinical side by

quoting Sugimura's observation in 21 autopsies that the walls of the lower part of the ureters are nearly always involved in acute cystitis, with only a little inflammation in the mucosa. In this discussion we have had in mind the paths by which bacteria which may reach the kidney, leave the bladder. It is possible, anatomically, that organisms once in the lymphatics may reach the kidney without entering the general blood stream, but the work of Crabtree [52] indicates that bacteria from the bladder travel in the finer lymphatics, the thoracic duct, then the blood stream, en route to the kidney.

Ascending infection by growth of bacteria along the ureteral mucosa is hardly supported by facts. Ascending infection through the lumen of the ureter is to-day considered rare, if not impossible, without the presence of obstruction to the flow of urine from the kidneys. Renal infection may be dependent upon inflammation about the ureteral orifice, but this lesion has opened up the lymphatic paths. Ascending infection through the veins alone, except by advancing thrombosis, seems very improbable.

Mention should be made of Stewart's observations in experimental work on dogs—first,[13] that renal infection following the uretero-intestinal anastomosis depends somewhat upon the apparently increased virulence of the intestinal flora growing in ulcerations at the point of anastomosis; and secondly,[12] that the level of the gut at which the ureter is implanted has little effect on the probability of subsequent renal inflammation.

Summarizing, to reduce to a minimum the possibility of infection of the kidneys following ureteral transplantation, one should avoid (a) ureteral obstruction from twist, kink or constriction, (b) injury to the ureteral orifice, and (c) injury to the blood vessels and nerves in the wall and adventitia of the ureter. A pre-operative treatment with an autogenous colon bacilli vaccine might be beneficial. This was suggested by Oppel,[14] who noted in 19 cases of exclusion of the blad-

der by implantation of the ureters in the bowel, a less severe post-operative pyelitis in patients having a bladder infection than in those with clean bladders, due presumably to a better tolerance of that infection.

What is the prognosis of a case of exstrophy of the bladder, if not operated upon? His life is an existence of wretchedness, of abashment and pain. He is offensive to his friends and burdensome to his family—an outcast from society, socially and economically. For few such individuals have the ingenuity and patience to properly care for a urine receptacle and their bodies and clothes and thus maintain an atmospheric environment acceptable to their associates. Marion [3] states that 90% die at birth or in early childhood, but according to Vigneau and Borger (cited by Barras [15] and Bucharon [2]) about 56% die under 10 years of age; and only about two-thirds of those surviving, or 30% of the whole, pass the twentieth year. In a very large proportion of deaths, the cause has been ascending urinary infection. This proneness to pyonephrosis is to be borne in mind when considering operation in a given case. In some instances of deaths following an operative procedure, an old inflammation of the kidneys has been found. Bérard and Cotte [16] and Vulliet [17] have had such experiences. Woolsey [18] encountered calculi in both ureters. Hence, examinations by ureteral catheterization, renal function tests and radiography should antedate operation.

The older methods of operation have been often reviewed. They require no description here.

Numerous autoplastic procedures have been devised to cover in the bladder and to construct a new urethra. If skin is used to make the anterior wall, calculi and phosphatic incrustations are likely to form and will cause great pain. Only those methods utilizing mucous membrane should be used. Complete closure is difficult to obtain, and patients are often submitted to a series of operations to accomplish this result.

It can be said in criticism of all these plastics that they provide no sphincter to control the urinary flow. Although, according to Mayo,[19] Goebel has successfully constructed a sphincter of the pyramidalis muscles. The penis is apt to be drawn up too high for functional use, or in the female vulvo-vaginal adhesions may form. On the other hand, these plastic operations often relieve pain for a while, and provide a better means of collecting urine in a receptacle. The literature shows that a number of patients thus operated upon have subsequently applied for relief from calcareous incrustations or from incontinence. In addition to and as an aid to plastic work on the bladder, apposition of the pubic bones has been employed. The chief types of procedure are represented by Trendelenburg, who cuts the sacro-iliac ligaments, and by Albarran, who cuts the horizontal pubic and the ischio-pubic rami. The advantages of these bone operations are slight and do not warrant the risk involved. A partial continence has been secured [20] in 13% of cases operated upon by Trendelenburg's method, due presumably to a mechanical result obtained by contact of the bladder walls. Later observations on some of the Trendelenburg cases had demonstrated a reseparation of the pubic bones.

Diakonow [21] has by blunt dissection formed a sinus extending from the bladder, through the perineum, between the sphincter ani and the rectal mucosa, to the skin at the anal margin. This is lined by a strip of bladder mucosa and forms a new urethra controlled by the sphincter ani. The bladder is closed at a later operation. Subbotin is given credit for suggesting such a canal, but made no effort to line it with epithelium. Lerda [22] proposed a similar method, using a skin flap, and Thiersch grafts to line the new canal. These procedures have obvious possibilities, but are relatively new, and judgment at this time would have to depend more on speculation than on reported facts.

Implantation of the ureters on the skin or in the vagina,

and nephrostomy, both relieve the patient of bladder pain, are safer as regards kidney infection than uretero-intestinal anastomosis and make easier the wearing of a urinal. Nephrostomy is compatible with many years of life. But all these devices fail to obviate the most aggravating of all the patient's symptoms—incontinence.

Incontinence and the other symptoms as well are adequately cared for by shunting the urinary stream into the bowel. But the risk of infection of the kidneys is increased. The surgical problem is how to reduce this to a minimum. Implantation of the ureters, cut across above the bladder wall, into the intestinal tract has been employed in many cases of exstrophy and other bladder conditions. We have come across 13 methods [48, etc.] involving this principle. Some form a new bladder of a loop of bowel, which is made to communicate with the skin or with the bowel. In the latter case the object is to prevent the passage of feces across the ureteral openings. Other methods make a direct implantation into the bowel carrying the fecal current. Of this group we will mention two. First, the well-known Coffey [23] operation, which when carefully and properly performed, promises well. C. H. Mayo [19] reported four exstrophy cases so treated without operative mortality. We found no late reports of such operations. Second, implantation of the ureters in the sigmoid with the embedding of 3 cm. or more of each ureter in the wall of the sigmoid (like the technic of a Witzel gastrostomy) has been tried a number of times. Brewer [24] and J. A. Johnston [25] each report a case so treated well after 3 years. Cuneo [26] isolates a loop of ileum, preserving its mesentery, and anastomoses the bowel above with that below the loop. The ureters are transplanted into this loop, and one end of the loop brought out between the sphincter ani and the rectal mucosa. Five recent cases have been reported [26 27] with one operative death. Heitz-Boyer and Hovelacque [26] cut across the rectum, leaving the superior hemorrhoidal

artery in the lower bowel. The proximal end of gut is brought to the skin, passing within the sphincter ani but without the rectal mucosa, and the upper end of rectum is closed by suture. Later, the ureters are separately placed in the isolated rectum which becomes a newly-formed bladder. Three cases have been reported,[26] [28] [17] with one operative death; one case [26] was living and voiding every 2 hours, 18 months after operation. Lastaria [29] modifies this method by stripping muscle and serosa from that part of the bowel placed between sphincter ani and rectal mucosa, to reduce the volume and avoid over-stretching the muscle. Taddei [30] and Verhoogen [26] have isolated the cecum, done an appendicostomy, and implanted the ureters into the cecum. A catheter was worn in the appendix, and urine drawn off at stated intervals. Reports of these novel methods are too few and too recent to fix the value of them. We believe these cavities will always be infected, and do not expect the results of these methods will warrant the risk of such extensive operations.

At least 9 methods [49, etc.] and modifications of ureterointestinal anastomosis aim to preserve the ureteral orifices intact. Most of these are not supported by enough clinical data and do not possess sufficient novelty of principle to justify consideration. Soubottini [31] formed of the anterior rectal wall a channel which was joined to the bladder above and controlled by the sphincter ani below. The edges of the remainder of the rectal wall were sutured, and this tube continued to serve as rectum. It was of course still controlled by its sphincter. The operative mortality is 25%, and a technical failure means disaster—loss of control of both urine and feces. Maydl's operation and that of Bergenhem stand preeminent as the procedures of choice among all the uretero-rectal anastomoses used for the relief of the symptoms of exstrophy of the bladder. They relieve the pain and practically always give urinary control.

From Buchanan's excellent summary [2] of reports *pub-*

lished to 1909, we obtain the following data concerning Maydl's method [32] which is a direct intraperitoneal implantation of the trigone, including both ureteral orifices, in the wall of the rectum. Moynihan [33] did the operation extraperitoneally in one successful case. The immediate mortality is 28.7%. Of 57 recoveries, 65% have lived one year and 24% over 5 years. If we add to Buchanan's list of Maydl's operation the 16 cases cited below, published since 1909, and not included in his article, the immediate mortality becomes 28.1%. Of 69 recoveries from operation, 66.7% have lived over 1 year and 26.1% over 5 years. These figures are practically the same as those taken from Buchanan's article. Bergenhem's operation [34] consists essentially of the independent extraperitoneal implantation of the ureters, each with a rosette of bladder wall, into the rectum, with removal of the bladder. It is known also as Pozza's [35] operation, and as Peters' [36] operation. On adding to Buchanan's list the seven cases cited below, published since 1909, and not included in his article, the immediate mortality for the Bergenhem operation is changed from 11.5% (Buchanan's figure) to 15%. Of 28 recoveries from operation, 60.7% have lived over 1 year and 21.4% over 5 years—practically the same proportions as those given by Buchanan.

On comparing the two operations, the striking facts are the higher primary mortality of the Maydl operation, the peritoneal invasion and risks involved, and its greater complexity and difficulty. The Bergenhem operation is extraperitoneal and simpler. After recovery from operation, the outlook is about the same. Both procedures presume careful dissection of the ureters with the minimum of trauma to their walls and adjacent tissues in order to protect the nerve and blood supply therein. Both aim at preservation of the ureteral orifice. Both lose the blood and nerve supply reaching the ureters from the bladder. This study has confirmed us in the belief held five years ago—the time of operation on our case, re-

ported below—that the Bergenhem operation offers the best future for a patient afflicted with exstrophy of the bladder.

In doing the Bergenhem operation one should carefully avoid injury to the ureter and its adventitia and should avoid kinks, twists and tension. The sphincter ani should not be dilated, for fear of permanent injury; in some patients this muscle is abnormally weak. A tube is left in the rectum a week or more, to drain off the accumulating urine. Buchanan's suggestion to hold the rosette of bladder wall to the skin margin by a suture seems sound. An intestinal suture is unnecessary, and may do harm by constricting the ureter as it passes through the wall of the rectum. To prevent this possibility several authors have advised that a ureteral catheter be left in each ureter a few days after operation. But this involves additional risk and seems unnecessary. If anuria occurs, inspection of the ureters and uretero-rectal junctions should be unhesitatingly made. Oppel [14] encountered anuria in a case in which a procedure similar to a Witzel gastrostomy had been done. Sixty hours after the first operation, he intervened, found the ureters dilated with urine, severed the ureters above the anastomosis and at once reinserted them less snugly, higher in the sigmoid, by a technic identical with that first employed—with a successful result.

The following sixteen cases of Maydl operation which have been published since Buchanan's report, will be noted very briefly.

1. Case of Guinard: [20] Patient with one kidney, well after 8 years.
2. Case of Erdman: [24] Mentioned in discussion; died 12th day, pneumonia.
3. Case of Broca: [20] Died of ascending infection.
4. Case of Broca: [20] Died of ascending infection.
5. Case of Panchet: [20] Operative death.
6. Case of Panchet: [20] Death from ascending infection, 12 months after operation.

7. Case of Panchet:[20] Death from ascending infection, 14 months after operation.

8. Case of Panchet:[20] Death from ascending infection, 15 months after operation.

9. Case of Ewald:[37] (Not in Buchanan's summary.) Boy, 4 years, well after 12 years.

10. Case of Ewald:[37] (Not in Buchanan's summary.) Boy, 18 months, well after 8½ years.

11. Case of Graser:[38] Girl, 4½ years, well after 5 years.

12. Case of Graser:[38] Boy, 7½ years, well after 1 year.

13. Case of Robineau:[39] Girl, 7 years, had had good plastic operation, occasional attacks of supposed renal infection followed Maydl operation.

14. Case of Van Sweringen:[40] Boy, 13 years, well after 9 months.

15. Case of Whitacre:[41] Woman, 21 years, well after 1 year and 7 months.

16. Case of Woolsey:[18] Boy, 3, removed 2 stones from right ureter and 5 from left ureter at time of the Maydl operation, well after 8 months.

The following six cases of Bergenhem operation have been published since Buchanan's report.

1. Case of Augier:[42] Boy, 17 years, died 40 hours after operation. Autopsy performed, cause of death not known; had passed urine from the bowel.

2. Case of Arumugan:[43] Boy, 10 years, well 5 weeks after operation.

3. Case of Ball:[44] Boy, 5 years, well 9 months after operation.

4. Case of Feutrie:[1] Died of "uremia" 24 hours after operation. Cause of death not clear from description.

5. Case of Simpson:[45] Girl, 8 years. Operator carried the ureters through the vagina, then placed them in rectum; well 18 months after operation.

6. Case of A. Thompson:[46] Boy, 9 years, died 2 years and 3 months after operation with convulsions, dropsy and fever.

Author's Case

A Jewish boy, aet. 16, undersized, was first seen by us in February, 1911. He had had three unsuccessful attempts made to close the exstrophied bladder at two years of age. His general health was fair. In the suprapubic region there was an inflamed exposed area of bladder mucosa 4 cm. in diameter, the upper and lateral borders of which consisted of scars from the earlier operations. There was complete epispadias, partly bifid scrotum, and a 4 cm. separation of the pubic bones determined by palpation under an anesthetic. The radiographs indicated a separation of 10 cm.—a discrepancy noted before,[51] and due to incomplete ossification or to faulty technic in radiography. The recti muscles were widely separated. The exposed bladder was exquisitely tender and was intermittently flooded with urine. It was partly hidden from view by the upturned flattened penis. The testicles and spermatic cords were normal. The prostate was of usual size but twice as wide laterally as in the antero-posterior diameter. Small, slightly distended seminal vesicles were palpated, extending up from the lateral borders of the prostate. Normal prostatic fluid was expressed from the open urethra by massage of the prostate, and a few inactive spermatozoa were found. A small right inguinal hernia was present, and marked bulging over the left external ring.

Urine caught as it dripped from the bladder was clear and contained only a few leucocytes, but myriads of bacilli and micrococci. A phthalein test was done—the color appeared in 9 minutes, and 36% was recovered in the first hour, although considerable urine was lost. Under a general anesthetic, a bladder large enough to hold a small hen's egg was found. There were neither calculi nor incrustations, but many small

papillary excrescences were noted, scattered over the bladder mucosa. The verumontanum was present and appeared to be normal. The ureters were easily found, functioned normally, and admitted catheters easily. The urine obtained from the ureters showed neither pus nor bacteria microscopically.

Operation was performed April 6, 1911, under gas and ether anesthesia. Catheters were placed in both ureters. A rosette of bladder wall, including the muscle, was dissected free about each ureteral orifice. The ureters were freed high enough so that they could assume the straightest course from the brim of the pelvis to the rectum. The left ureter was accidentally broken into early in the operation, and the rent promptly sutured. A curved artery forceps was introduced in the rectum. On the tip of this, a small opening was made in the left antero-lateral rectal wall, 2 or 3 cm. above the internal sphincter. The forceps were made to protrude, to grasp the edge of bladder wall about the left ureteral orifice after the catheters had been removed, and withdraw the ureter well into the rectal lumen. Similarly, the right ureter was placed in the rectum. No suture was taken in the rectal wall. What would come away easily of the bladder wall was removed.

A tube was kept in the rectum the first four days after operation, and the rectum irrigated several times a day. Urotropin was given before operation and for many weeks afterwards. The temperature ranged between 100 and 102 for ten days. On the fifth day there was pain and distinct tenderness of the left kidney. These entirely disappeared in 48 hours. Similar attacks (always in the left kidney) recurred twice in the following two months, but never subsequently. There was considerable odorless oozing from the wound for ten days, then a definite urinary leakage. This urinary fistula was completely healed four weeks after operation.

Because of the tenderness of the exposed mucous membrane,

a second operation was performed on May 18th. The mucosa on the penis, and the more exposed bladder membrane were excised. The deeper part of the latter was not removed, because it was very adherent from previous operations, very vascular, and not exposed to trauma.

The patient was discharged from the hospital June 15th, voiding at intervals of 2 to 6 hours. For some months there was frequently nocturnal incontinence. The control in this particular has gradually improved so that now there is wetting of the bed only about once a week and then but a small spot. The patient voids urine, often quite free from feces, every 3 to 5 hours and sometimes goes 7 hours. He gets up at night once or not at all. By measure, a single voiding is often over 350 c.c. The bowels move usually twice a day and the patient can often distinguish in anticipation between a passage of urine and one largely feces. Occasionally a laxative is needed. Erections and frequent seminal emissions have been annoying the past three years. Papillæ nearly 1 cm. high are formed by the ureteral projections in the rectal lumen and can be readily palpated, 2 to 3 cm. above the internal sphincter ani. Efforts to collect urine directly from the ureters through an endoscopic tube inserted through a proctoscope have not been satisfactory. The voided urine is slightly cloudy, and the sediment from a centrifugalized specimen contains only a moderate number of scattered pus cells. Of 6 mg. phenolsulphonephthalein given intramuscularly, about 25% was recovered from the rectum in 2 hours and 10 minutes. The patient is at work, is in perfect health, and is changed from a wretched, dejected, lonely boy to a bright and happy lad with a real interest in life.

We wish in conclusion to emphasize the wisdom of a careful preliminary examination of the condition of the kidneys before any operation is undertaken on a case of exstrophy of the bladder. Without records of the late history of many patients, it will be impossible to compare the term of life fol-

lowing various procedures with the reasonable expectation of life without any operation. But with our present knowledge, from the humanitarian, the social, and the economic viewpoints, operation in exstrophy of the bladder is clearly indicated if there be no severe renal infection. Methods which effect no control of the urine offer but little comfort to the patient. The simpler procedures that do provide a sphincter are to be preferred. The newer methods which form an extra-intestinal, perineal channel, lined with epithelium and controlled by the sphincter ani, have not been sufficiently tested clinically. We believe that uretero-intestinal anastomoses offer the exstrophy patients the best outlook, at the present time. The subject is intimately associated with bladder exclusion for other ailments, and the problem of control of ascending infection is deserving of all the experimental and clinical work being done.

Inasmuch as many of the successful cases have given clinical evidence of temporary renal infection in the first few days following operation, it would probably be safer to transplant the ureters one at a time with an interval of several weeks between operations.

For exstrophy of the bladder, Bergenhem's operation appeals to us as the best. It seems well established clinically and experimentally that preservation of the ureteral orifice is worth while, whether it acts as a valve or sphincter or whether its preservation merely offers a more circuitous and less likely route for ascending infection to follow in order to reach the ureteral lymphatics. Possibly future observations will indicate that preservation of the ureteral orifice should be combined with embedding the ureter within the bowel wall.

Finally, while we have found a report of no case of double uretero-intestinal transplantation living over 5 years after any operations other than those which retain the uretero-vesical orifice, there are at least 27 such (including the author's

case) following the Maydl and Bergenhem methods and their modifications—and one (case of Rous[47]) is well 17 years after a Maydl operation.

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THE VALUE OF BACILLUS BULGARICUS IN TREATMENT OF COCCUS INFECTIONS OF THE BLADDER

By R. F. O'Neil, M.D., of Boston

SINCE Dr. Caulk drew the attention of the Association at the 1914 meeting to the brilliant results obtained in the treatment of incrusted cystitis with an emulsion of the Bulgaricus Bacillus, we have been considerably interested in following out this treatment in all suitable cases. We think the report of results obtained and our conclusions drawn therefrom may not be without interest.

I shall not take the time to go into the pathogenesis, descriptions of the lesions or symptomatology of the disease, which are all well known and have been fully described; but will give the histories of a few cases more or less in detail, which we believe well illustrate certain points of importance.

In all of our cases of incrusted cystitis the cultures showed a growth of streptococci and staphylococci, bacillus proteus and bacillus coli. Beyond this no attempt was made to plate out any given strain of bacteria. The cultures in our cases after treatment showed, with two exceptions, colon bacilli only.

Preparation Used. In the earlier cases emulsions made from tablets were used. These were not very satisfactory and the tablets examined almost invariably showed a contamination, mostly with cocci and a few various kinds of bacilli. This was proved by cultures on milk and then worked out on other media. A large Gram-positive staphylococcus being most common.

We then used the liquid culture put up in 10 c.c. tubes which on examination showed pure culture of Bulgaricus

Bacilli. I understand there is now a new tablet on the market said to be reliable but we have had no experience with it nor have we had any experience with the Bacillus Acidophilis.

The technic is simply to inject 20 c.c. into the bladder through a catheter after preliminary cleansing irrigations. If the patient is on constant drainage the catheter is plugged or clamped off for a couple of hours. If there is an open suprapubic wound, some attempt is made to hold the edges together for a time at least. The treatment should be given daily to obtain good results, and be accompanied by the administration of acid sodium phosphate. There were no reactions from the injections in any case.

The cases roughly fall into two groups: First, those showing more or less incrustations on the bladder wall alone, and, second, those which show in addition a marked tendency to the formation of phosphatic calculi, recurring rapidly after removal—most of our cases of this type having undergone multiple operations for the removal of calculi.

The following are illustrations of the first group:

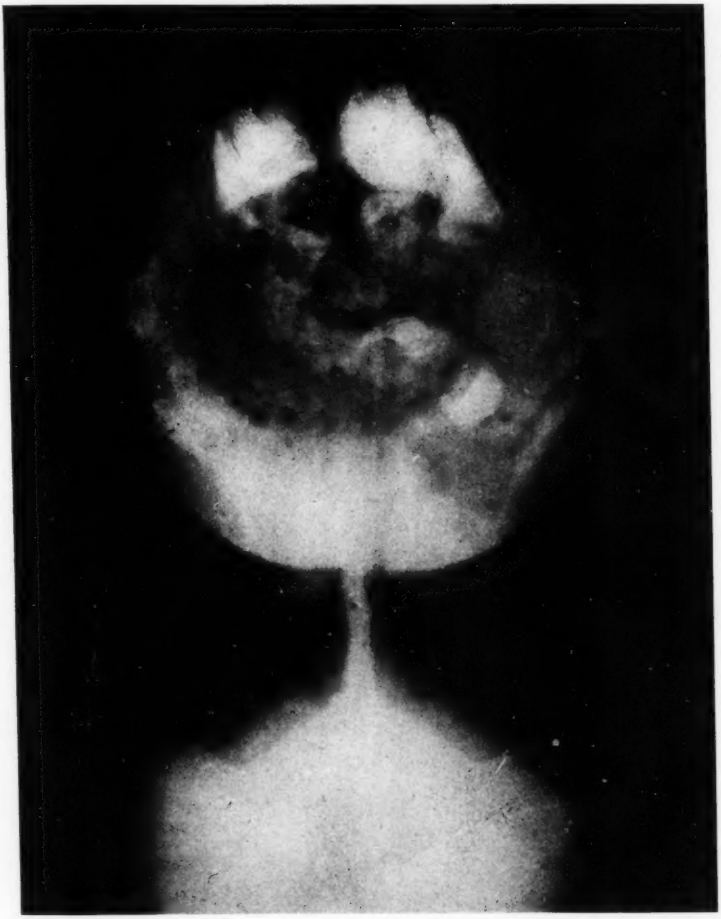
Case 1. G. U. Department Massachusetts General Hospital. A. E. 41. Single. Insurance agent. First seen in O. P. D., June 26, 1915, with the following history: Presenting symptoms, frequent and painful micturition; duration 7 years. Has passed white chalk-like material from bladder and of late the urine has contained blood. At present, micturition day and night at intervals of one-half hour to an hour; intervals never longer than an hour. Three years ago pain in right kidney region, none at present. A previous X-ray said to have been negative for stone. Bladder very irritable. Urine contained blood and clots. Put on Ol Santali; urine taken for examination for T. B., an X-ray (see Plate IX) taken showed a curious mottled appearance in region of bladder from which a diagnosis of incrusted bladder was made. July 7.—Has passed 15 phosphatic fragments since last visit. Some obstruction and grating in deep urethra. July 10.—

Urine cloudy but not bloody; alkaline. Smear showed a Gram-positive coccus. 20 c.c. emulsion of Bulgaricus Bacilli put in bladder. July 13.—Urine acid. Patient still passing calculi. July 29.—Came in with fragment stuck in posterior urethra which was pushed back into bladder. Has been having almost daily treatment with bladder injections of 20 c.c. of emulsion of Bulgaricus Bacilli. The urine is acid. A urethral stricture has been dilated to No. 26 French, and the bladder holds 4 ounces. A radiograph (PLATE X) taken a week ago shows considerable diminution in amount of calcification in bladder region.

Aug. 9.—X-ray (PLATE XI) shows some phleboliths but nothing in bladder region. Aug. 16.—Bladder is not now irritable. Cystoscopy. Mucous membranes generally roughened but paler than usual. No vessels seen. No calculi seen but in some places what seem to be adherent mucopus. Right ureter in normal position. Left not made out. Sept. 2.—Urine strongly acid. Patient has received treatment at irregular intervals. Oct. 1.—When last seen, practically no treatment for a month. Condition poor; is having chills and frequency. Patient has been lost sight of but at the last visit was evidently failing rapidly from what we supposed to be a bilateral renal tuberculosis. A guinea pig inoculation from patient's bladder urine was positive. The ureters were never catheterized. Although highly unsatisfactory from a clinical standpoint, this case is of interest as showing the power of the Bulgaricus Bacillus to combat the alkalinity of the urine and incrustation formation even in the presence of the underlying infection, which in this case was tuberculosis. This is well demonstrated by the successive X-rays, the cystoscopic examinations and the improvement in the urine while the treatment was being regularly carried out.

CASE 2. C. L. E. 29. Married. Colored. Housewife. G. U. Department, O. P. D., Massachusetts General Hospital. Five years' frequency of micturition and pain in left

PLATE IX—Presented by Dr. R. F. O'Neil



Radiograph before treatment. Note the well marked shadow of the incrusted bladder; also the mottled appearance, which is typical.

flank. April 13.—Cystoscopy showed an incrusted cystitis with alkaline urine. Culture showed streptococci. Treatment started with Bulgaricus Bacilli. April 25.—Cystoscopy. Urine alkaline. Areas of incrustation much less than at previous examination. Both ureters catheterized. Urine from right, acid with a little blood; no bacteria. Albumin s. p. t. (blood?). Urine from left faintly acid. Epithelial cells. No tubercle bacilli. Streptococci. Albumin, trace. May 2.—Improving. Treatment continued. This case is still under observation and is of interest because the ureters were catheterized and the reaction from the kidneys shown to be acid and faintly acid against the bladder urine being strongly alkaline. There is as yet little improvement in the urinary symptoms but the incrustations have practically disappeared.

The following cases are illustrative of the type associated with the rapid formation of calculi:

Case 1. Mrs. G. 33. Private case of Dr. H. Cabot. Feb. 16, 1916.—Two and one-half years ago, following childbirth, bladder infection. One and one-half years ago, stone in the bladder crushed. One year ago suprapubic cystotomy showed an incrusted bladder. Passing small stones very frequently, always in pain.

Examination.—Healthy-looking woman. Catheter specimen of urine strongly ammoniacal; cloudy, alkaline, 1024, albumin good trace, sugar 0. Sediment shows pus, many varieties of bacilli, some Gram-negative streptococci and staphylococci, some other bacilli, probably Proteus Vulgaris. Bulgaricus Bacilli put into bladder. Rx. Acid sodium phosphate.

From the 18th of February to March 29th eight treatments at varying intervals. Urine remained alkaline. March 29.—Entered hospital. Urine has been acid since three days after entrance. Cystoscopy shows fewer incrustations around neck of bladder than at previous examination. With operating

cystoscope these were picked off, a few small particles washed out; the rest left to be passed. April 15.—Cystoscopy under ether shows a small incrustation near the vesical neck on the upper right-hand side, and a small one on the lower left side. Bladder otherwise normal. These incrustations were on the base of a considerable slough, but were removed with the curette. April 22.—Cystoscopy shows a slough remaining on the left side of vesical neck but without incrustation except at five o'clock where there is a very small incrustation. April 25.—Bladder washed out; small particles in wash water apparently corresponding to what was seen at last observation. Urine strongly acid. Instillation of Bulgaricus Bacilli continued. This case shows the necessity of constant regular treatment, as no results were obtained until the patient was placed in a hospital. She will be kept under observation and it seems reasonable to suppose that she can be kept free of calculi.

Case 2. J. Male. 67. March 24, 1915, entered G. U. Service of the Massachusetts General Hospital. Urinary symptoms for a long time. Had passed gravel. Incontinence for two years. Bladder very irritable. Urine foul; alkaline. Culture shows staphylococci and streptococci. Cystoscopy, spinal anesthesia, shows a considerably incrusted bladder and a small, white calculus at base. Litholapaxy. March 31. —Daily treatment with Bulgaricus Bacilli 20 c.c. liquid culture. Cystoscopy. Bladder irritable but mucosa not reddened. No evidence of incrustation remaining. One or two flakes of adherent mucopus. Urine remained acid while in hospital. Summary.—This is a case of bladder infection of unknown origin associated with alkaline urine and a coccus infection, resulting in calculus formation. Complete cure in a week by litholapaxy and acidulation of the urine by Bulgaricus Bacilli.

Case 3. J. Mc. 76. Female. J. 29, 1915, entered G. U. Service of the Massachusetts General Hospital. Frequent painful

PLATE X—Presented by Dr. R. F. O'Neil

Shadows still visible, but mottling much less extensive.

and difficult micturition for 11 years. For last five years in constant pain and has passed gravel; on one occasion acute retention from fragment. April 15.—X-ray shows a shadow in region of bladder, probably stone. Cystoscopy.—Bladder mucous membrane red and dirty, with incrustations and a calculus size of sparrow's egg. April 30.—Litholapaxy; spinal anesthesia. Fragments washed out; put on constant drainage. Daily treatment with 20 c.c. liquid emulsion of Bulgaricus Bacilli. Urine acid in 24 hours. Aug. 24.—Four months after operation. One month after operation began to have frequency and pain. Two months after operation began to pass small stones and pus. Has had no treatment with Bulgaricus Bacilli since leaving hospital. March 9, 1916.—Has vesical incrustations and has passed a good deal of calcareous detritus. Cystoscopy.—No calculus but area of incrustation and a few small phosphatic granules. March 10.—Emulsion of Bulgaricus Bacilli injected. Urine acid. Feels much more comfortable. Summary.—This case relapsed immediately on the cessation of treatment, and showed immediate improvement on its being resumed.

Case 4. S. L. Male. 68. July 9, 1913. G.U. Service, Massachusetts General Hospital. Suprapubic prostatectomy. Oct. 2, 1914.—Cystoscopy shows considerable prostatic tissue remaining, two white calculi and a very considerable incrustation of bladder wall. Urine alkaline. Culture shows colon bacilli and large numbers of streptococci and staphylococci. Oct. 13, 1914.—Litholapaxy. Urine alkaline. Oct. 20.—20 c.c. Bulgaricus Bacilli injected after residual had been withdrawn. Urine strongly acid next day. Oct. 26.—Daily treatment with Bulgaricus Bacilli. Cystoscopy shows a small amount of phosphatic detritus adherent about trigone. No evidence of large deposits seen at the time litholapaxy was done. Ureters, which had previously been hidden by incrustations, easily seen. Culture shows Bulgaricus Bacilli and Colon Bacilli. Oct. 30.—Feels well. No

residual. No irritation. Urine hazy, acid, many colon bacilli. Nov. 7.—Urine Acid. Culture shows colon bacilli and a large coccus. Dec. 14.—Has continued about same. Reporting regularly for treatment; when he omits it the urine becomes alkaline but quickly becomes acid on resuming injections. April 22, 1916.—Two months ago passed a small stone. Urine cloudy and alkaline. Residual 12 ounces. Cystoscopy shows a deep median cleft; considerable prostatic tissue remaining; a small white calculus behind left ureter. April 29.—Litholapaxy, local anesthesia. This case still has residual urine from incomplete prostatectomy. While under observation was in good condition. Urine could be kept acid. All treatment given up and he returned with alkaline urine and calculi.

Case 5. S. W. Male. 63. G.-U. Service, Massachusetts General Hospital. July 14, 1915.—Bladder trouble for 10 years; frequency, with occasional stopping of stream. In 1911 had a "tumor above the prostate gland" removed. Urinary symptoms were not relieved by this operation. Passed several small stones. In 1914 four large stones were removed. In June, 1915, a stone in the bladder was crushed; four days later passed a small stone. Cystoscopy.—Bladder much inflamed. Considerable remaining prostatic tissue. A light phosphatic calculus in base of bladder. July 15, 1915.—Litholapaxy. Urine has been alkaline. Treatment with emulsion of Bulgaricus Bacilli. Urine became strongly acid after 48 hours, and remained so during stay in hospital. In October, 1915, his physician reports that the patient is free from calculus. The urine is acid and is kept so by using Bulgaricus Bacilli once in three weeks. Mar. 2, 1916.—Cystoscopy, spinal anesthesia—A very much reddened bladder with a diverticulum in the roof; no stone present. Ureteral catheter passed into diverticulum shows it to be about one inch deep and containing no detritus. Placed on constant drainage. Mar. 14.—Has been quieting down steadily, although urine still

PLATE XI—Presented by Dr. R. F. O'Neil

Mottled appearance has disappeared. Only a few pleboliths to be seen, which are visible in the other plates.

shows pus. Has been using bladder irrigations and injections of Bulgaricus Bacilli ever since last operation for stone. April, 1916.—Re-admitted to Massachusetts General Hospital for treatment of urinary symptoms; apparently pericystitis. Summary.—This is a case of prostatic obstruction with a marked tendency to the rapid formation of phosphatic calculi. By constant use of emulsion of Bulgaricus Bacilli the urine has been kept acid and there has been no calculus formation for over 10 months.

In addition to the cases showing definite incrustation and calculi, we have been in the habit of employing the emulsion of Bulgaricus Bacilli as a routine in all cases where the bladder has been opened and an alkaline urine persists after operation. We have also employed it in the treatment of sloughing and incrusted urinary wounds.

Conclusions

From the analysis of these and other cases we feel justified in drawing the following conclusions:

1. That the incrustations met with in this form of coccus infection, with an alkaline urine, can be more rapidly and permanently removed by the acidulation of the urine by the injection of Bulgaricus Bacilli or some other acid-forming bacteria, than by any other means.

2. That in certain cases where the incrustations are associated with alkaline urine and a marked tendency to the formation of soft phosphatic calculi, their recurrence may, to a considerable extent, be prevented by maintaining a strongly acid urine by this means.

3. That the method may be of value in the treatment and prevention of the incrustations sometimes seen in urinary wounds.

4. That the treatment to be of value must be carried out

at regular intervals and will show better results in private practise or when patients are confined in the hospital, than when treated in Out-Patient Departments.

5. That the method is of little permanent value where the infection is not confined to the bladder.

DISCUSSION

Dr. William F. Braasch, Rochester, Minn.: Cystography has not been used widely because of the greater ease of vesical diagnosis by means of the cystoscope. Furthermore, the field of cystography is limited. Interpretation of the so-called filling defects in the outline of the bladder must be conservative, because evident defects may appear without the bladder being completely filled. In the female this interpretation is particularly uncertain because of the variable conditions in the adjacent pelvic organs. The method is also of limited value in the urethra. Pathologic conditions in the posterior urethra can usually be better demonstrated by the urethroscope.

As far as the diagnosis of diverticulum of the bladder is concerned, cystography is not as valuable as the shadow-casting catheter.

In cysto-ureterography, we have a method that may occasionally be of much value, particularly where it is impossible to catheterize the ureter. This is particularly true with inflammatory disease in the ureter and kidney. However, it will be found that cysto-ureterography is not practicable in all cases. Whether or not the ureter is filled with the opaque medium depends on whether or not the meatus is patent, which in turn is dependent on the degree of inflammation in the bladder wall. Occasionally, even though there is marked inflammatory dilatation of the lower ureter, it may not be filled by this method.

Dr. James Pedersen, New York: I saw an interesting case of bladder incrustation a few days ago, so recently that the laboratory data are not at hand, but the history, furnished by the surgeon who brought the case for an opinion, is unusual. The patient had an anterior colporrhaphy performed last December. During the convalescence a severe secondary hemorrhage occurred, which was controlled by further suturing, apparently. An indwelling catheter was used, whether immediately after the primary or only after the secondary operation is not known. All her bladder symptoms, great frequency, pain, with pus and blood in the urine, date from that time.

Cystoscopy showed that the bladder base had been folded into a ridge in the antero-posterior mid-line, that on the ridge were three

papillary growths, two of them beautifully crusted over with the characteristic white deposit, and that posterior to these were little tumefactions, looking something like bullous edema, much congested. Our supposition is, that either the bladder base was included in the original sutures, or had to be included at the time of the secondary operation to control the hemorrhage, and that the papillary growths resulted from the traumatism and the irritation of the sutures.

I advised curetting and fulguration by way of the urethra, or fulguration alone, and injections into the bladder of suspensions of the Bulgarian bacillus. Eventually, suprapubic cystotomy with radical removal of the growths was performed as the quickest way of returning the woman to her household work.

Dr. Francis R. Hagner, Washington: I think Dr. Kretschmer's observations on ureters that will let this fluid go up (he made the point they were normal ureters) are very interesting. Some of the gentlemen will recall that a few years ago I reported regurgitation of fluid around the ureteral catheters. All of my patients had deformed ureteral orifices and occurred in patients with infected kidneys. And yet he comes here and shows us these pictures where this same condition occurs with a normal orifice and without any catheter through it.

I was very much interested in Dr. O'Neil's paper on the Bulgarian bacillus. We know very well that after a suprapubic prostatectomy a considerable proportion of these cases will get yellow sloughs in the suprapubic wound and often depositions of calcareous material on the slough, and it is one of the objections to the suprapubic route. It has been our experience and we have a standing rule with all our cases that the nurse twice a day at least takes litmus paper and tests the reaction of the urine coming out of the suprapubic wound. The minute there is any alkalinity we begin using the Bulgarian bacilli. We have not had a single case of bad sloughing and no cases of incrustations since.

We have used the tablets principally. Some of them are absolutely no good, and some of them are, but one advantage the tablet has over the culture is that it does not dissolve when you make your emulsion and you put it into the bladder, and the particles adhere to the bladder wall, and the growth takes place more readily than when suspension (as a culture) that washes out with the urine is used. If you could take a culture and mix it with sugar of milk

or some such substance it would probably be better than the tablets.

We had an interesting case shortly after I heard Dr. Caulk's paper where we thought the man had tuberculosis of the bladder. He had an alkaline cystitis. We cystoscoped him, catheterized the ureters and found the urine from the right ureter alkaline. He had lost twenty pounds in weight and appeared quite ill. He was running a fever all the time. We took cultures from the catheterized specimens and found a pure culture of the staphylococcus. We gave this man an injection of two tablets into the pelvis of the kidney. Within twenty-four hours he had a very severe chill and a temperature of 105, which came down promptly. The next day his temperature was normal. He began to improve at once. We catheterized the ureter four days later, and the urine was perfectly clear and culture taken from the ureter showed no organisms at all. The man has continued well for two years now, without return of the pyelitis.

Dr. James A. Gardner, Buffalo: I wish to add just a word to what Dr. O'Neil has said regarding the Bulgarian bacillus. We had a very interesting case last fall in which a man had been operated on by another surgeon for suprapubic prostatectomy. Five months had elapsed and this patient had been unable to get out of bed because of a picket fence temperature. He had a profound alkaline cystitis. They had sort of given him up and felt they had done everything they knew. His kidneys had been affected and the surgeon thought there was little chance for him. We used the culture, injecting on three occasions. That is practically all we did but within thirty days from the time we first saw him, when he had been running a temperature up to 104 every day, the wound had healed. It had not healed up during the previous five months and he made an uneventful recovery, although they had tried every way to clean up the cystitis. It was so simple it was almost like magic.

Dr. Geo. K. Swinburne, New York: I think it was in 1898 that I reported the only case of phosphatic incrustations that I had ever had before this Society. I thought that the methods I reported at that time might be of interest now. It happened in the days when we were using bladder irrigations of permanganate. That man was a deck hand and remained at work. His bladder would only contain about an ounce of urine, he was suffering all the time, and yet he remained at work. He was a very powerful fellow. Making

as well as I could at that time a microscopic examination of the sediment and staining it I found numerous colon bacilli; I could not make out any other microorganisms, and he was passing from time to time these phosphatic calculi. During the first month he received daily irrigations from the meatus into the bladder of hot permanganate. I would use the entire quart, and could get in only an ounce at a time. Finally this amount increased. He would have considerable comfort after each treatment, but the condition remained bad. Gradually he began to improve, and at the end of a month we were able to make the treatment once or twice a week, and at the end of three months his bladder cleared. I reported the case at that time; it was one of the worst cases I ever had. The incrustations had ceased to form, and he ceased to pass them on urinating. The bladder capacity returned to normal, the urine became clear.

Dr. W. P. Willard, San Francisco: I would like to ask Dr. O'Neil if he has found any cases in which he was unable to grow the lactic acid bacillus in the bladder? I have one case now in which for the last six months I have tried every conceivable way to get a growth. I have tried milk and many other things as media in the bladder.

Dr. W. C. Quinby, Boston: I want to congratulate Dr. Stevens on his splendid result in the case of exstrophy. I have made a number of experimental observations on this general subject, and want to say that, in my opinion, he has used the only reasonable method of meeting these very serious conditions of developmental anomaly. I tried persistently over a year ago, to make an artificial, sterile bladder in animals from the lower end of the rectum. Such an artificial bladder is quite easy to make and I wished to see what success one might have in keeping it sterile, or, if not sterile, the seat of non-pathogenic bacteria.

It is evident, of course, that no artificial bladder has any special superiority over the rectum as a place into which to divert the urine if it cannot be kept practically sterile. In dogs it was impossible by irrigation to make such an artificial bladder sterile; or even to overcome the bacteria which were present in the beginning by any other bacteria of non-pathogenic character. Of course, one cannot control the post-operative care of a dog the way one might of a human being, nevertheless I feel quite sure that the proximity to the anus of such an artificial bladder will preclude its value. There-

fore, again I feel that Dr. Stevens has used the only method that really has any special claim to practical use.

One other point which he did not bring out but which is really of great importance in treating such cases. A good many men have tried to reunite the separated symphysis. This is always a radical mistake, as has been pointed out by the work of Hovelacque, the French anatomist, because besides there being deficient union at the symphysis there is also a bad articulation at the sacro-iliac synchondrosis. By approximating the symphysis the patient is thrown out of balance and distinct harm done.

Dr. Hugh Cabot, Boston: I want to record a case similar to that of Dr. Stevens, now of two years' standing, somewhat different as to operation. I was following the line mentioned by Dr. Quinby, attempting to get a pouch of intestine separated from the intestinal tract, so that I did the operation in two stages. I first opened the abdomen, divided the sigmoid from the descending colon, and implanted the descending colon into the upper rectum, leaving a long pouch of sigmoid, which I then fastened transversely to the abdominal wall beneath the bladder. A month later I finished the operation by taking the button at the end of the ureter and turning that right down into this pouch of sigmoid, which was practically extraperitoneal at that time because of the adhesions which had been established. That boy has done very well. Interestingly enough, he returned and is now in the hospital on account of hernia, which I suspect is likely to follow these operations on account of separation of the lower ends of the rectus muscles. He has done very well; holds his urine from three to five hours. Like Dr. Stevens' case, he had marked evidence of kidney infection immediately following operation. There was no doubt in my mind that the infection was bilateral, because it occurred at separate times, first on one side and then on the other. It is also my impression that he had a later infection of the kidney, about two months after operation, notwithstanding which fact he has continued to grow. He is a healthy looking boy of ten at the present time. I am well satisfied that he is better off than if I had attempted any of the plastic operations or had left him alone. I turned the ureters into the sigmoid, and that communicates as a pouch, of course, with the rectum. It is sidetracked from the upper rectum.

I would like to say a word on this question of the Bulgarian bacillus, in regard to what actually goes on in these bladders following injection. I have myself grave doubts as to whether the organisms actually grow in the bladder, or whether the benefit obtained is from the acid produced by the organisms immediately after their implantation. I am not at all sure that the life history of these organisms in the bladder has any duration. Our cultures in these bladders, in work carried out very faithfully by Dr. Crabtree, have shown that it has been impossible to reclaim the Bulgarian bacillus from the bladder more than forty-eight hours after injection, even in the cases where there is residual urine and in which any solid substance or oil put into the bladder would remain for many days. I am not at all sure that we are not using an acid in these bladders which happens to work very well and which has no relation to the organism used. In other words, if we put lactic acid into bladders they would do just as well. I am inclined to doubt the theory that the organisms grow.

Dr. Kretschmer (closing): In closing I wish to emphasize this point, that the possibilities of error in interpreting these pictures are many, and great care must be exercised in making the interpretations.

Regarding Dr. Hagner's question, the patients in whom this regurgitation occurred were divided into two groups: (1) Patients with normal bladders, without infection, and in whom the ureters appeared normal; (2) cases in which there were pathological changes present in the bladder. I do not think that the degree of retention or residual urine in the bladder makes any difference. In one of our patients, a child of nine, in whom there were 500 c. c. of residual urine, there was no regurgitation of fluid, so that stretching the bladder does not seem to have anything to do with it. We were impressed in some of our normal cases in whom this regurgitation occurred by the fact that they had a great deal of tenesmus. Whether the increased intravesical pressure is to be taken into consideration or not I do not know. In one case of tuberculosis of the bladder in which there was considerable change around the ureteral orifice there was a reflux up the pathological side, but *also up the normal side.*

In patients in whom cystography was carried out following prosta-

tectomy we found a sharply defined picture. In only one did we find a flow from the bladder into the urethra.

Dr. Stevens (closing): In my effort to keep within the prescribed time I hastened over points which both Dr. Quinby and Dr. Cabot have referred to. Dr. Quinby's point is a very good one, and is borne out by late results of the Trendelenburg procedure. You will recall that Trendelenburg cuts the sacral ligaments and pulls together the bones in front. Cases have been reported a year or more following operation where the X-ray showed clearly that the bones had pulled apart.

There have been three or four operations devised such as Dr. Cabot speaks of; one of them uses the upper part of the bowel to form a separate loop, and brings that down between the sphincter and mucosa; and the one that he speaks of as being done by a certain Frenchman, uses the rectum as the new bladder and brings the upper part of the bowel down beside the rectum out between the mucosa and the sphincter.

There was one case reported a year and a half after operation that is getting along very well. In these operations I do not see why we should not utilize the idea of keeping intact the ureteral sphincter. Apparently the published reports have cut the ureters across. It is pretty well proved that good is to be obtained by keeping the ureteral orifices, and it seems to me that idea could be incorporated with this scheme.

Inasmuch as many cases, some living five years afterwards, have good clinical reasons to make one think that there was infection of the kidney immediately after operation, it seems to me it is decidedly the wiser course, if one uses the Bergenhem operation, to implant one ureter at the first operation and later to implant the other one.

THE EXCRETION OF HEXAMETHYLENAMIN BY DAMAGED KIDNEYS

By George Gilbert Smith, M.D., of Boston

IN the management of renal infections the medical profession has been accustomed to place considerable confidence in hexamethylenamin. This drug is excreted by the kidney and is broken up by acid urine into ammonia and formaldehyde. Despite the conclusions of some investigators, who allege that the splitting off of formaldehyde does not occur until the urine has reached the bladder, clinical experience has taught some of us that renal infections of the most severe type can be controlled and perhaps cured by the administration of urotropin.[1]

It is somewhat disturbing, therefore, to read in a paper by Falk and Sugiura, issued from the Harriman Research Laboratory of the Roosevelt Hospital, that "in a number of pathological cases involving impairment of kidney function, abnormally small amounts of hexamethylenetetramine was excreted." Their results have apparently been taken by some genito-urinary surgeons as applying to all damaged kidneys. If their statement is generally true, urotropin must be placed on the shelf along with the other false hopes of the pharmacopeia.

It seemed to us important to investigate this question. In the first place, upon what evidence do Falk and Sugiura base their conclusions?

They determined the quantity of urotropin by a method which depends upon the precipitation of urotropin by the

[1] The words "urotropin" and "hexamethylenamin" are used interchangeably in this paper, although hexamethylenamin was the drug used in our experiments.

addition of an alcoholic solution of iodine. This test does not take into consideration the free formaldehyde which may be present (personal communication from Falk).

This seems to us a possible source of error. Some of the specimens were examined by Falk and Sugiura a good many hours (at least 20) after they were voided. During this period, if the urine were acid, a splitting-up of the urotropin present undoubtedly was going on. The writers partially cover this point by saying that if the test for hexamethylenamin is "negative or doubtful, the test is confirmed by acidifying a few cubic centimeters of the solution with sulphuric acid, warming, and then testing with phloroglucin and alkali for formaldehyde." The absence of the latter, they conclude, "proves conclusively the absence of hexamethylenetetramin."

We would answer this point in two ways. First, they apply this acidifying test only when the test for urotropin is "negative or doubtful." If urotropin is present in small quantities, they do not use this control. Secondly, the test for formaldehyde which they employ seems inadequate. In the 40 observations on normal urines given by them, there is one strong test for formaldehyde, one "faint to strong," and three "fair." All the others are faint, very faint or negative. The work of Burnam and my own work upon the question of the presence of formaldehyde in urine gave a much larger proportion of positive results. We used the phenylhydrazine, sodium nitroprusside and sodium hydrate test; they used the phloroglucin and alkali test.[1] The point is a difficult one to make clear without further data, but it seems that if the test used by Falk and Sugiura gave only 5 positive results out of 40 observations on normal urine, it cannot be relied upon as a control for the excretion of hexamethylenamin.

[1] In my experience, Burnam's test has shown itself 3 or 4 times as delicate as the phloroglucin test. This does not agree with the findings of Hanzlik and Collins, however, who consider phloroglucin the more delicate.

If the urine to be tested contains albumin, it must be submitted to the following process before the estimation can be made. "An equal volume of methyl alcohol is added, the mixture allowed to stand one or two hours at room temperature, filtered by decantation through folded filter paper, evaporated to one-third the volume in a current of air or under diminished pressure."

It has been shown that urotropin dissolved in acid urine and allowed to stand for several hours at room temperature will be partly broken up, and that the urine will then give a definite test for free formaldehyde. It seems to us highly probable that during the process of filtering, evaporation, etc., through which albuminous urines are put in Falk and Sugiura's test, the urotropin, at least in part, is converted into formaldehyde, and the latter, being simply a gas in solution, escapes. Urine from damaged kidneys is usually albuminous; it is this urine which is subjected to the preceding test. These investigators do not mention control experiments upon normal urine to prove that the process does not drive off urotropin in the form of formaldehyde; it appears to us justifiable to believe that the test itself, which is not the same for normal and for albuminous urines, may be one cause of the apparently diminished urotropin content in urine from damaged kidneys.

Falk and Sugiura applied their quantitative test for urotropin to the urines of various normal individuals, and found that the ingestion of one gram of urotropin was followed by the excretion in the urine of quantities of the drug varying from 11 per cent to 74 per cent of the amount ingested; that in general the absolute amount of urotropin excreted by the kidneys increased as the specific gravity of the urine decreased. "The lower the specific gravity of the urine, the larger was the amount of hexamethylenetetramin excreted." They do not attempt to explain this phenomenon, but apparently regard it as being connected in some way with the

kidney. They do mention the possibility of its being due to differences in the absorption of the drug by the gastro-intestinal tract. To us, this seems to be the explanation. The normal kidney is remarkable for the uniformity of its work; upon this quality the various functional tests depend. To secure uniform results, however, a definite quantity of the substance used must be introduced into the blood-stream; the factor of absorption from the gastro-intestinal tract at once diminishes the accuracy of the test as a measure of renal function.

It is highly improbable that the healthy kidney, which excretes the test drugs with such uniformity, behaves in so capricious a manner towards hexamethylenamin. It is highly probable, on the other hand, that varying conditions in the gastro-intestinal tract—the presence of food, the acidity of the gastric juice, the amount of fluid in which the drug is diluted—alter in the same individual the amount of urotropin which is absorbed. Quite possibly the ingestion of much water aids in the absorption of urotropin, thus accounting for the observation that high urotropin excretion and low specific gravity go hand in hand.

The low output of urotropin by some of the pathological cases cited by Falk and Sugiura may be due to conditions affecting the metabolism of the entire body, such as anasarca or a state of impending death, which must have greatly diminished the absorptive powers of the stomach and intestines.

The output of the drug was studied by Falk and Sugiura in 24 pathological cases. One gram was given, and the urine collected for the next 12 or 24 hours. Nine of the cases (15, 17-24) were under treatment for diseases,—tuberculosis of the knee, leukemia and syphilis of the brain, for example—which had no particular connection with the kidneys; three others (13, 14 and 16) had arteriosclerosis, which might possibly have had renal manifestations. Of these 12 cases—half

the series—there is no evidence presented to show that there existed any real damage of the renal tissue. In three of them, indeed, we are told nothing whatever about the renal condition. Yet of these 12 cases, only two show an output of urotropin greater than 13 per cent. Four of them show only a trace.

The other 12 cases are all renal—one nephroptosis, one septic infarct (unilateral), one amyloid kidney. The other nine are chronic interstitial or cardio-renal cases. They excrete urotropin rather better than do the twelve with healthy kidneys—27 per cent, 86 per cent, 79 per cent, 24 per cent, 61 per cent, are the five best outputs. Of the others, two who died put out only a trace, and one with a retained nitrogen of 164 and a phthalein test of 0, put out none.

Careful study of this series of observations fails to show any constant relation between the renal condition and the urotropin output. The amount of urotropin excreted averages less than in the series of healthy kidneys; that may be due to the effect of the test itself when applied to albuminous as contrasted with non-albuminous urines, or may be due to the poor absorptive powers of many of the pathological cases. One would hardly expect a patient in the last stages of leukemia to have a very robust metabolism.

The evidence produced by Falk and Sugiura does not warrant the conclusion that damaged kidneys do not excrete urotropin in sufficient quantity to be of bactericidal value.

In order to test this point still further, we have examined the urines of 14 patients whose kidneys were unquestionably damaged, many of them to a marked degree.

Not being proficient enough to employ the test used by Falk and Sugiura, we have had to rely upon the test for formaldehyde described by Burnam. As a rough measure of the concentration of the formaldehyde, positive urines were diluted until they no longer gave a positive test. The last dilution giving a definitely positive test we took to be a 1-300,-

000 solution, since formaldehyde added in known quantities to normal urine ceased to give a positive test when diluted beyond this point. By dividing 300,000 by the number of dilutions, the approximate strength of the original solution was arrived at. This method, unfortunately, was suggested only toward the end of the investigation, and was employed only in the last few cases.

The cases studied fall into two groups: (1) The "surgical" kidneys resulting from renal calculus, obstructing prostate, etc., and (2) the "medical" nephritis of chronic interstitial or glomerular type.

Ten cases with kidneys damaged by infection were studied. The evidence of bilateral damage was found in the decreased phthalein output plus the clinical history. Seven of them were old men of the prostatic class; one was a bilateral pyelitis, one bilateral renal calculi, one a rather obscure case of a septic infarct or eclamptic kidney. The prostatics had been taking urotropin gr. x 4 times a day for varying periods; the others had been given gr. xv three or four hours before the urine was collected. Of these 10 cases, the urine contained free formaldehyde either before or after boiling with sulphuric acid (depending largely upon the acidity) in quantities sufficient to give a moderately positive test (dark green with Burnam's method) in 4 cases, and a strongly positive test (bluish or blackish green) in 6 cases. Of the strongly positive cases, the strength of formaldehyde present, estimated by the dilution method, was 1-40,000 once, 1-30,000 twice, 1-10,000 three times. The strength of the moderately positive tests was probably not more than 1-60,000 to 1-100,000.

Perhaps the case most strikingly illustrative of the ability of damaged kidneys of this type to excrete urotropin was that of Mrs. L., aged 52, whose X-rays showed huge calculi in both kidneys. After the intramuscular injection of 1 c.c. phenolsulphonephthalein solution, no color appeared in the

urine for 35 minutes. In the hour following the appearance of the color, less than 5 per cent of the dye was excreted. She had been taking urotropin gr. xv three times a day for several weeks, and the urine showed a urotropin content of at least 1 part in 10,000.

From the study of this group of ten cases, all of whom had that type of kidney disease which is usually treated by urotropin, we do not find evidence that the output of urotropin is reduced below the point of efficiency.

Examination of 4 cases of the nephritic type, however, gave different results.

Case 1. Age 58. Chronic glomerular nephritis, with phthalein excretion of 20 per cent first hour and 25 per cent second hour, non-protein nitrogen of 42, after 1 dose of gr. xv urotropin, excreted urine containing free formalin in very strong concentration. (Bluish black color.)

Case 2. A girl of 26, with good function, 40 per cent first hour, and 10 per cent second hour, non-protein nitrogen of 32, and a diagnosis between chronic glomerular nephritis and kidney destroyed by some antecedent inflammatory process, put out neither urotropin nor formaldehyde within 4 hours after taking gr. xv of urotropin.

Case 3. A woman with chronic glomerular nephritis, less than 5 per cent phthalein excreted in 2 hours, and 74 mgm. non-protein nitrogen, put out only the slightest trace of urotropin 10 hours after a dose of gr. xv, and none at all after 2 doses 16 and 4 hours previously.

Case 4. A man of 46, with a question of bilateral polycystic kidney, phthalein excretion of less than 5 per cent in 2 hours, and non-protein nitrogen of 97 mgm., excreted only a small amount of formaldehyde (moderately positive test); this appeared only after 5 hours had elapsed since ingestion of the drug.

In a previous paper on the excretion of formalin in the urine, I stated that "the kidneys of chronic nephritis, to judge

from a few observations, excrete urotropin much more slowly than do normal kidneys. One dose of grains xv has given traces of formaldehyde in the urine for 36 hours." From the very limited number of cases of nephritis which we have studied in this connection, it would appear that serious disease of the glomeruli greatly decreases the ability of the kidney to excrete hexamethylenamin. If this is true, the diminished excretion of this drug in chronic glomerulo-nephritis should not affect the position of hexamethylenamin in the treatment of renal infection. According to Cabot and Crabtree, colon infection affects the epithelium of the tubules. Excretion of hexamethylenamin by the glomeruli is not interfered with, and the drug, as we have shown, is put out in good quantity.

In view of the above findings, we believe that the statement of Falk and Sugiura in regard to the low output of hexamethylenamin by kidneys with impaired function is of very little practical importance. Close analysis of their paper shows several probable sources of error in their procedure, and these errors all tend to represent the urotropin output as less than it really is. Of the 24 pathological cases studied by them, 12, or one-half the number, fail to present evidence of any value pointing to true renal disease. These 12 cases, furthermore, show a lower output of urotropin than do the 12 cases of renal disease in the same series.

No conclusions as to the value of urotropin in those cases in which it might be expected to do good can be drawn from the work of Falk and Sugiura.

As positive evidence on the question of the output of urotropin by infected kidneys, we have presented facts drawn from a study of 10 cases of undoubted renal disease of this type. In every case urotropin was excreted; in 3 cases, in a strength of 1-10,000; in 2, 1-30,000; in 1, 1-40,000. It was weaker in the other four, although strong enough to give a definite test with Burnam's method. In chronic nephritis of advanced degree, we have found in three cases a diminution

in the output of urotropin which would be a serious factor in its employment as a therapeutic agent. Fortunately, in such cases it need seldom be employed. In kidneys damaged by infection, even to a very marked degree, the drug may be excreted in a strength as high as 1-10,000. One must bear in mind the very important fact that no matter how much urotropin is excreted, it will be useless as a bactericide unless it is broken up into formaldehyde by urine which is definitely acid.

DISCUSSION

Dr. John T. Geraghty, Baltimore: I was very much interested in Dr. Smith's paper. Personally I think there is some question whether urotropin is of any value at the kidney level whether it is excreted or not. We have come to the view that urotropin is of practical value only in the lower urinary tract, because the amount of formaldehyde depends not only on the amount of acid but on the length of time the acid is in contact. The urine stays so short a time in the kidney pelvis that there is no time for the liberation of formaldehyde.

Dr. Hugh Cabot, Boston: I am inclined to draw swords with Dr. Geraghty on that point, for this reason: in a series of five cases of colon bacillus infection of the kidney, with very high temperature and with the urine slightly acid or neutral, they continued to have chills and remained in very bad condition, in spite of the administration of hexamethylenamin, which was obviously doing no good because the urine was not acid. In all those cases the administration of drugs sufficient to produce acidity of the urine immediately stopped the fever. It seems to me in all human possibility that action can take place only in the bladder. But the action which immediately stops a fever, which puts an end to chills by the formation of formaldehyde in the urine, can, as I see it, only take place at the level of the kidney. I believe the explanation lies in the fact that most of these cases have some amount of renal retention and that they probably get more benefit from the drug than would a normal kidney under those conditions. It seems to me that the experimental and the clinical work there fight head on, and I must believe that these formaldehyde-containing drugs do act at the level of the kidney.

Dr. Smith (closing): There is a certain amount of experimental evidence to show that the drug is broken up in the kidney in animals. Hanzlik and Collins did a good piece of work on this in 1913. They put catheters in dogs' ureters and collected the urine as it came out and found formaldehyde in good quantity. It has been shown also—I found this out for myself—that urotropin is broken up very readily in two or three minutes to quite a marked degree in strongly

acid urines, and the pelvic capacity, which is from three to seven cubic centimeters, I think, is enough to hold a residual urine that will permit of the drug being broken up. I believe during that time enough formaldehyde is liberated to at least inhibit the colon bacillus.

Second Day, May 10th, 1916

TRAUMATIC INJURIES OF THE UPPER URINARY TRACT: KIDNEY AND URETER

By Henry G. Bugbee, M.D., New York

THE subject of traumatic injuries of the upper urinary tract is worthy of further consideration because of the relative rarity of these lesions, because of certain difficulties which beset the diagnosis, and hence the treatment, of some of them, and because it is always profitable to record additional cases of rare conditions, thereby helping to keep them in mind as possibilities with which to reckon.

For these reasons, I have made a fairly comprehensive review of the literature to date, studying the cases recorded by others, and noting seeming advances in diagnosis and treatment. I have not attempted a complete tabulation of cases as given in the literature. The number is now sufficiently large, with the exception of those concerning injuries of the ureter alone, to render such a task unsatisfactory, in view of the fact that one is seldom able to command the entire literature of any given subject, because of the overlapping of reports and the consequent enumeration of cases already reported, and for the further reason that a certain number of cases, buried in unexpected places and under misleading epitaphs, will always be overlooked. To these reasons may be added the fact that many cases are reported in such an incomplete and unsatisfactory manner that their evidence is inconclusive and their value of doubtful moment.

To the list of cases I wish to add nine, of which eight

involve the kidney, and one the ureter. Some of these patients were admitted to my service at the Vassar Brothers' Hospital, Poughkeepsie, N. Y.; others have come under my care in the hospitals in New York City.

The rarity of traumatic injuries of the upper urinary tract is accounted for, in part, by the anatomical situation of the organs involved, and in part, according to some writers, by the fact that the correct diagnosis is not made. The former fact, especially at this stage of the development of diagnostic skill, is doubtless the chief explanation.

The kidneys and ureters, placed deeply beneath the surface of the body, are protected anteriorly by the ribs, anterior abdominal wall, and intraperitoneal organs; laterally and posteriorly by the skeleton and powerful muscles.

Injuries of the upper urinary tract are most often subparietal, subcutaneous or subdermal—not associated with external wounds—and are in the nature of contusions, lacerations, and ruptures. Injuries associated with external wounds are generally due to stabbing or shooting, though various other accidents have been recorded.

Kidney

Summaries of cases of traumatic injuries of the kidney have been compiled by Delbet[1] in 1901, Watson[2] in 1903, Suter[3] in 1905, Lardennois[4] in 1908, and Connell[5] in 1911, the last-named author adding to previous lists 147 cases, of which he found "either mere mention, or a more or less complete report," thus bringing the number up to 875. Since the appearance of Connell's paper, there seems to have been no exhaustive review of the literature so far as case reports are concerned, though a number of articles on the subject have appeared, recording one or more cases. The two largest single series which have come under my notice are those of Lüken,[6] who, in 1914, reported 47 cases, treated in the

Leipzig Clinic (Trendelenburg Director), during the years 1895 to 1911, inclusive, and of Ponomareff,[7] who, in 1914, reported 57 cases observed during the years 1898 to 1912, inclusive. I have found, dating from the appearance of Connell's contribution, records of 224 additional cases. I do not wish, however, to convey the idea that no other cases have been reported, for the reasons already stated. These, with the 8 cases which I shall add, bring the total number of reported cases of traumatic injuries of the kidney up to 1107. This is probably a fairly accurate estimate, inasmuch as it may be considered that the number of cases overlooked is perhaps more than counterbalanced by those, included in the summary, in which the recorded facts leave room for doubt as to the diagnosis.

Causes of Injury. Lardennois[4] divides ruptures of the kidney into three general classes, which apply likewise to injuries other than those usually denominated as rupture: (1) Those due to *direct trauma* (kicks; blows; falls upon stones, beams, bars, etc.; being crushed between two wagons, by wheels, etc.; and other manifestations of direct force applied over the region of the kidney). (2) Those due to *indirect trauma* (violent horse-back riding; falling on the feet). (3) Those due to *muscular action* (sudden springing backward; heavy lifting; sudden movements in the effort to catch objects or to dodge blows; etc.).

In 45 out of 770 cases reviewed by Lardennois,[4] the cause of rupture was found to be shock or blow upon the anterior abdominal wall, and in only three of these were other abdominal organs injured.

The fact that the blow or force does not need to be very severe in order to cause serious injury, even complete rupture, of the kidney, is demonstrated in a number of reported cases. Gargam,[8] for example, in 1881, cited a case in which rupture of the kidney resulted from the individual striking against a table. A similar case, in which the patient struck himself

against a counter, was reported by Borzy,[9] in 1900. In Borzy's case hematoma was found, with a rupture, large enough for the insertion of a finger, in the lower half of the kidney. It was with difficulty that the cause of the injury was elicited, when the patient was seen some time subsequently,—the fact being taken to signify the trivial character of the accident.

A case, frequently mentioned, was cited by Voit, in which a woman, while dancing with her husband, who held her very tightly round the waist, felt a severe pain in her right side. Hematuria set in at once, was very abundant, and lasted two months, intermittently. At the end of this time the perirenal effusion began to suppurate. Lumbar incision for purposes of drainage revealed the fact that the kidney was ruptured. This case, sometimes mentioned as an illustration of rupture by muscular action, also suggests the presence of some concurrent contributory factor.

The following case, in my series, illustrates the point that relatively slight muscular action may result in injury to the kidney.

Case 1. J. A., male, 32 years old; chauffeur, with negative family and previous personal history. In June, 1914, while bending down and cranking a car, patient felt a sharp pain in the left side of the abdomen, beneath the costal margin, became faint, and had to lie down. After a few minutes he was able to stand, and with assistance to go home. For two weeks he was unable to work as a chauffeur, owing to the pain in the side, when he tried to stand or move about. At the end of this period he did some work, but had to stop work and go to bed again. He then had a constant pain in the left side of the back, and began to run a temperature ranging from 100 in the morning to 103 at night.

Six weeks after the injury I saw the patient, and found on examination a large, firm, tender mass in the left lumbar region, extending from beneath the costal margin to the crest

of the ilium. The mass was slightly movable, and was easily felt anteriorly on bimanual palpation. The urinary examination was negative, as were likewise the cystoscopic examination and ureteral catheterization. The patient's temperature at this time was 103 degrees and the pulse 110. The diagnosis of hematoma secondary to laceration of the kidney, the result of muscular violence, was made, and operation advised.

I made a lumbar incision, and, upon reaching the perirenal fat, a large, broken-down hematoma was encountered. Nearly a quart of thick pus was evacuated, and a laceration found in the kidney, at the junction of the lower and middle thirds of the organ. The laceration extended down to but not into the kidney pelvis. There was still some oozing from the torn kidney surface. The wound in the kidney was packed with gauze and the lumbar incision closed about it. The patient made an uneventful recovery. Subsequent analyses of separated urines have shown a functional capacity of the left kidney equal to one-half that of the right. Here, then, was an extensive laceration of the kidney, due to muscular action of a moderate degree of violence, with extensive hemorrhage, but with no extravasation of urine and no changes in the urinary stream.

Fauntleroy,[10] in 1912, reported the case of a robust seaman, 21 years old, who had fallen a distance of two feet, while cleaning the forward turret of the ship, striking the left side of the abdomen against the ball attached to the stock of a small anchor which was lashed to the side of the turret. The kidney was exposed by a Mayo incision, whereupon it was found that there was still active hemorrhage, and on both the anterior and the posterior surfaces there was a large rent in the capsule and parenchyma extending on both surfaces, from the convex border into the hilum. In addition to this, the central part of the viscus was soft and pulpy, rendering it impossible to suture the wounds, and necessitating nephrectomy.

Atkinson,[11] in 1914, cited the case of a girl 14 years old, who, while running after a dog, ran across a fifteen-foot porch into a light wire netting at the edge of the porch, and fell two feet, into a flower bed of soft earth. Despite the fact that the child could not have acquired great momentum in the distance covered, severe symptoms immediately supervened, and operation revealed a laceration extending right through the kidney substance, the upper pole being much more severely injured than the lower.

A case, similar to the preceding as regards the relatively trivial character of the accident, came under my observation in 1914.

Case 2. J. W., male, aged 6 years. Family and previous personal history negative. In May, 1914, patient fell from a park bench, a distance of 2½ feet, striking on his left flank. He fainted, and was carried home. An hour later he passed urine deeply colored with blood. He complained of pain in the left flank. When seen by a doctor marked tenderness was found in the left kidney region. Ice was applied, and the patient was kept quiet in bed. There was no elevation of temperature, no mass appeared in the side, and the hematuria diminished.

Two weeks later, when seen by the writer, the patient had been allowed to get up, and the hematuria had returned. At this time the patient presented a palpable left kidney, tender, but not irregular. No mass was felt outside the kidney. Ureteral catheterization showed a profuse left-sided hematuria, but otherwise no change in the kidney excretion. Under rest the patient made a complete recovery.

In this case the laceration of the kidney communicated with the pelvis of the organ, yet there was no rupture of the kidney capsule. No hematoma formed, and there was no infection.

It is interesting, in connection with the study of cases in which injury to the kidney resulted from very slight force, to note that most of such cases reported are in young adults

and children, in some of whom, at least, there is a possibility of a causative factor in some abnormality of the abdominal viscera. The possibility of the persistence of infantile ptosis, as suggested by Aglave,[12] by leaving more of the surface unprotected by the thoracic bulwark, in the opinion of Gibson,[13] may account for some of the cases of renal traumatism in children. The particular vulnerability in childhood has also been ascribed to the minimum deposit of perinephric fat, according to Gibson, and the greater tension of the overlying peritoneum.

In the case cited by Atkinson,[11] it was found, upon median sub-umbilical exploratory incision, that about midway between the cecum and the splenic flexure there was a kink, formed by the lower end having a long mesocolon, allowing a partial volvulus. Just above this kink, and about on the level of the junction of the lower and middle thirds of the injured kidney, there was a transverse tear, about an inch long, into the lumen of the gut. Such cases suggest a line for further inquiry.

Gibson,[13] in four cases of complete rupture of the kidney in children, ranging in age from eight to twelve years, found a similarity in the lesions, which, with the fact that they were the same with different kinds of violence, seemed to him to confirm the theory of "bursting" by hydraulic pressure, as suggested by Küster.[14] From his review of the literature and the tabulated statistics of twenty-two cases of rupture of the kidney in children, Gibson believes these injuries to be more common than is generally estimated.

Küster's hydraulic pressure theory, as is well known, was evolved from experiments which consisted in distending the veins, arteries, and renal pelvis, then applying violence to the surface of the organ. Deep transverse lacerations, extending into the pelvis of the kidney, resulted. From these observations he concluded that the essential element in the production of rupture of the kidney is hydraulic pressure. This pressure,

acting through the renal pelvis and blood vessels, causes bursting of the viscus upon the receipt of a blow. The blow or other force may lead to rupture, whether it be applied directly against the back and ribs over the kidney, or indirectly from the anterior abdominal wall.

The rupture, according to Küster, is usually transverse, and takes place in the interlobular lines of the embryonic kidney. In Gibson's cases, however, the line of rupture was vertical to the long axis of the kidney, at about the junction of the two lower thirds. This would seem to indicate a different line of least resistance, such as Gibson had not seen mentioned in any of the treatises on the subject.

Morris [15] holds that the ribs play an important part in the production of traumatic injuries of the kidney. When the force is applied upon the back or sides it is directly transmitted to the kidney by the impact of the ribs upon this organ. When the force is directed upon the front of the abdomen it is indirectly transmitted, by impact of the ribs, to the kidney. In either case the kidney is driven against the unyielding vertebral column. It is more difficult, however, as Gibson has pointed out, to apply this explanation to those manifestations of indirect violence such as a fall on the feet.

The fact that the preponderance of cases of traumatic injuries of the kidney concerns males in the prime of life, as compared with their occurrence in females of any age and in children, would seem to be explained on the basis of the exigencies of active life rather than of any inherent predisposing condition or disease.

The part played by general arteriosclerosis, syphilis, and other affections, in predisposing to injury of the kidney by slight degrees of traumatism, has not been thoroughly investigated, so far as I am aware. It is conceded, however, that syphilis, arteriosclerosis, cancer, polycysts, and calculi, may render the kidney more susceptible to traumatic injuries.

Nature of the Injury. The injury to the kidney following

traumatism of whatever kind, may vary from tears of the fatty capsule, localized subcapsular hemorrhage, slight contusion or laceration of the parenchyma, to rupture of the pelvis of the kidney, injuries to the renal blood vessels, complete rupture, single or multiple, or general pulpification, with or without complicating rupture of the peritoneum or injury to other structures.

Swainson,[16] in 1914, operated upon a child, six years of age, who had fallen down five wooden steps, sustaining a rupture of the kidney into three portions, held together slightly at the pelvis, which was itself torn. Stellate fractures are reported in a number of cases. Rupture, complete and incomplete, may be entirely intracapsular, as in Case 2 of my series. Rupture of a single or horseshoe kidney was reported by E. O. Smith,[17] in 1915. Twenty-two cases of injury of the renal blood vessels were collected and reported by Vidakovic,[18] in 1913, and one case of injury of the suprarenal capsule was reported by Canestro,[19] in 1912. The right kidney is more often injured than the left. Bilateral injuries are rare. Franklin,[20] in 1912, reported a case in which the left kidney was "torn to pieces," and the right presented three transverse tears. The patient was a girl, sixteen years old, who had fallen from a wagon.

Habs [21] expressed the view that in all renal lesions there may be synchronous lesions of the peritoneum, the stomach, the intestines, the liver, and the spleen. If this be true, the aspect of the case would naturally be influenced thereby, and such a possibility should be borne in mind.

The experimental observations of Falcone [22] are interesting in this connection. He experimented upon eight dogs, reducing one kidney to a crushed mass. In the other kidney the results, in the first days after this operation, were extreme congestion, glomerular and interstitial hemorrhages, with oliguria, and the presence of albumin and white and red corpuscles. In the successive days the quantity of urine in-

creased, the color improved, but the albuminuria nearly always persisted, in some cases with cylindruria. Falcone concluded from these observations that, while a strict clinical application to man is not possible,—else the twenty-five per cent mortality in man given by Legueu [23] would be higher,—when any lesion is suspected in the uninjured kidney one should proceed without delay to remove the injured organ, since probably only by this radical means can the life of the patient be saved. These observations are worthy of further study.

Symptoms. Shock, localized pain, tumor (from hemorrhage into the perirenal tissues), hematuria, and changes in the quantity of urine, are the chief symptoms associated with injury of the kidney. The so-called classic symptoms (shock, pain in the lumbar region, and hematuria) are present in widely varying degrees of severity, and cases are recorded which emphasize the fact that all these symptoms may be absent for a varying length of time; also that one or more may be lacking throughout. In a case reported by Sears [24] nothing occurred for several days to direct attention to the kidney, despite the fact that an injury sufficiently severe to practically pulpify the kidney, was found at autopsy. In Fauntleroy's case,[10] mentioned above, the symptoms were meager. The following may be cited as a typical case, the injury being complete subparietal rupture of the kidney.

Case 3. The patient was a boy, aged 15 years. His history previous to February 19, 1910, was negative. On this day, while coasting, his sled turned, throwing him violently against an iron post. The blow was received squarely between the ribs and the crest of the ilium. He complained of severe pain in the side, but was examined by a physician, who expressed the opinion that he would be all right in a few days. Two hours after the accident he passed an ounce of bloody urine, and this was repeated an hour later. His condition became

alarming, and a second physician was called in, who advised his removal to the hospital.

I saw him nine hours after the receipt of the injury. He was then pale, cold and clammy, covered with sweat; the pupils were dilated; respirations gasping; pulse thready and irregular; temperature, 97. In other words, he was in profound shock. The right side of the abdomen was filled with a rather firm, rounded, slightly movable, tender mass. The remainder of the abdomen was distended, and the right half was tender. The diagnosis of rupture of the right kidney was made. The firmness of the mass indicated a hematoma and the absence of intraperitoneal injury.

After expectant treatment for several hours, during which time the patient's condition did not improve, an intravenous saline injection was given, and a rapid posterior exposure of the kidney was made. The kidney was found to be completely ruptured, transversely, the line of fracture involving the renal pelvis and vessels. The loin was filled with blood, urine and clots, which were cleared out. The pedicle was rapidly ligated and the kidney removed. The patient rallied at once, the remaining kidney functionated normally, and the convalescence was uneventful, the patient leaving the hospital at the end of six weeks.

The degree of *shock* present depends upon the amount of hemorrhage; also upon whether the injury to the kidney is complicated by injury of the peritoneum and other organs. It is held by some observers that the fatty capsule of the kidney tends to control the hemorrhage, and consequently influences the degree of shock.

Bloch,[25] in 1914, reported a case in which shock was apparently entirely absent. The patient, a boy of seventeen, walked into the doctor's office with the statement that he had struck his left loin against the corner of a table, and shortly thereafter had voided bloody urine. Careful examination revealed no cut, scratch, swelling, or other external indi-

cation that he had received an injury. His only symptom was hematuria. Exposure of the left kidney, after forty-eight hours of expectant treatment, revealed a large amount of extravasated blood, and a laceration of the kidney on its convexity of about two-thirds of its length, the laceration extending in depth about one-half of the kidney substance.

In some instances the shock is transitory, and failure to elicit a history of this symptom is doubtless sometimes due to this fact, especially if the injury is associated with considerable hemorrhage.

Intense lumbar *pain,* which is one of the characteristic symptoms, is very severe at first, as a rule, increasing in intensity during the first hour after the injury, probably as the result of the consequent and increasing effusion of blood, and the infiltration of urine into the perirenal tissues. Not infrequently the pain, severe at first, decreases or entirely disappears. In some cases of severe kidney lesions pain is never a manifest symptom. In the case reported by Sears [24] pain in the lumbar region was never present.

An important characteristic, noted by Habs, where hematuria is not present, is that pain radiates down from the lumbar region to the scrotum, the penis, and even to the thigh, due, presumably, to pressure from the effused blood on the nerves supplying this region. In one of the cases reported by Habs this was the only characteristic symptom.

The presence of a *tumor* in the renal region in cases of traumatic injury of the kidney depends, in many cases, upon the extent and localization of the hemorrhage. It may be due, as in cases reported by Perriol and Bosquette,[26] Mincer,[27] Wildbolz,[28] and others, to hydronephrosis or pseudo-hydronephrosis.

The fact that the tumor may be intermittently apparent, and that this state of affairs may extend through a number of years following traumatism in the loin, with presumptive injury to the kidney, is illustrated in the following case.

Case 4. F. V. T., male, aged 50 years. Thirteen years before admission to St. Luke's Hospital (April, 1916), the patient, while lifting a hog, was kicked in the left side. After this he had pain in this region, followed by the appearance of a "lump," which increased in size. He went to a hospital, where he was treated expectantly for three weeks. At the end of that time, according to his history, he felt something give way, whereupon he voided material which was very dark in color. The lump then decreased in size. Since that time the mass has been intermittently larger and smaller. When it decreases in size the urinary output is increased. He has had occasional attacks of pain in the lumbar region, sometimes in the nature of an ache; at others, it has been sharp and knife-like. There has been no hematuria since he left the hospital, three weeks after the injury. Following a recent attack of grippe, he experienced pain and tenderness in the left side, and was then admitted to the hospital.

Examination revealed the presence of a tumor in the left kidney region. Upon cystoscopic examination the bladder was found to be normal, except for slight congestion. Ureteral catheterization yielded concentrated, clear urine from the right side; from the left side, the urine was dark and cloudy, and flowed more freely upon pressure on the tumor mass, the mass, meanwhile, diminishing in size.[1] The urine from this side contained much pus, and showed very little functional capacity of the left kidney. The diagnosis of laceration of the left kidney, due to the blow in the loin, was made, with the development of a hematoma, and the breaking down of the hematoma, and the subsequent degeneration of the kidney. The patient refused operation.

Hematuria has been considered by Kocher and a number of other observers as the cardinal symptom of renal lesions. Voelcker,[29] on the other hand, considers this an

[1] The absence of obstruction in the ureter excluded a laceration of the ureter with subsequent stricture.

uncertain sign, not so reliable as the detection of retroperitoneal tumor, ecchymosis in the inguinal or scrotal region, or the indications of peritoneal tear. The danger of depending upon this sign, or rather the danger of being misled by its absence, is emphasized by numerous cases.

Stoney,[30] in 1910, reported a case in which a man, 28 years of age, was thrown from a bicycle, alighting on his shoulder. He was unconscious for a few moments, then went home. He remained in bed for two weeks, during which time he complained of pain in the right side. Not until he got up again did he notice blood in the urine. He then went to a hospital, where he was under observation for three weeks. The urine now contained a quantity of blood, which the Luys segregator showed to come from the right kidney. At operation it was found that the kidney was almost torn in two at the hilum, the lower half being in a state of pulp.

In a case reported by Ehrenpreis,[31] of complete rupture of the kidney in a man of 28 years, resulting from a fall from the seat of a carriage, hematuria did not appear until the tenth day after the accident. In the case reported by Sears,[24] the urine, while high-colored and of high specific gravity, and decidedly acid, presented no macroscopic evidence of blood until the fifth or sixth day. The quantity of blood then increased rapidly, and clots filled the bladder to such an extent that a more or less firm tumor could be easily outlined in the lower abdomen. In this case, it will be remembered, autopsy showed a pulpified condition of the kidney.

In Case 4, of my series, hematuria was present only once, three weeks after the injury, during a history of thirteen years.

The absence of hematuria, in a case reported by Greensfelder,[32] was accounted for by the presence of a clot in the pelvis of the kidney which prevented the urine or blood and urine from passing down the ureter.

Johnson[33] calls special attention to cases of traumatic

renal affections in which the hematuria is intermittent, and describes a parenchymatous hematoma, the capsule of the kidney being intact. In the following case from my series hemorrhages into the cortex of the injured kidney were demonstrated.

Case 5. H. L., female, aged 20 years. Two weeks before admission to the hospital patient fell out of bed, giving her body a sharp twist. Since that time she has had pain in the left lumbar region. Four days after the fall she had a chill, fever, vomiting, slight hematuria, and continued severe pain in the left kidney region. Tenderness of the lower pole of the kidney, which was palpable, was elicited. No tumor was demonstrable, and the kidney was apparently not enlarged. Urethra, bladder and ureters normal. Upon ureteral catheterization, urine from the right kidney was found to be acid, there was transitory albuminuria; leucocytes few; function normal. Urine from the left kidney was neutral, with transitory albuminuria, few leucocytes and red blood cells, some epithelial cells; function diminished. X-Ray examination revealed a definite kidney outline, of regular contour, with an increased density of the kidney shadow, particularly of the lower pole.

The symptoms of pain and tenderness diminished after a week of rest in bed. The patient left the hospital and it has not been possible to follow the after-history.

In this case, as in many others, which do not come to operation, it is not possible to make an absolute diagnosis, but the findings,—history of injury, localized symptoms, tenderness of the kidney, hematuria, diminution of function, increased density of kidney shadow,—seemed to be sufficient to warrant the diagnosis of intra-renal hemorrhage, with slight laceration of the pelvis and no break in the capsule of the kidney.

Many of the cases reported in the literature emphasize the fact that very slight symptoms do not preclude the possibility

of severe or even fatal hemorrhage; and that the intensity of the hematuria is not always in relation to the gravity of the lesion, as pointed out by Legueu,[23] Cathelin,[34] and others. It is well known that very slight injury may cause severe hemorrhages in cases in which the injured kidney is the seat of polycystic formations, of malignant neoplasms, and of calculi.

On the other hand, it is not to be overlooked that a perirenal or renal hematoma may become organized. Gyselynck [35] cites such a case in which, a year and a half after the injury, the kidney was found to be the seat of a tumor the size of the fist, situated on the posterior surface. The tumor was in reality a cystic pouch formed from the tissue of the kidney, which had become enlarged. It contained liquid blood and a quantity of coagulum that appeared to constitute a veritable tissue. The following case from my series is an illustration of this possible outcome.

Case 6. H. D., male, aged 29 years. While playing football, in 1909, the patient was accidentally kicked in the left side of the abdomen, just below the ribs. This area was tender for several months, and he had an occasional attack of dull, aching pain, over the left kidney, which persisted, at intervals, until 1913, when I first saw him. He had had no urinary symptoms. Upon examination a moderate increase in the size of the left kidney was detected, the lower pole of which was easily palpable. The kidney was tender on bimanual palpation. A radiograph showed an irregular area (not a definite shadow) in the lower pole of this kidney, of varying and greater density. Ureteral catheterization showed slight decrease in the function of this as compared with the right kidney; otherwise, was normal. Combined radiographic and cystoscopic examination gave no irregularity in the outline of the pelvis, and the dense area (thickened kidney) was not in immediate contact with the pelvic margin. No operation was performed, but the findings indicated an organized

hematoma in the lower pole of the kidney, caused by the injury. The hematoma did not communicate with the pelvis of the kidney, hence no urinary symptoms were present.

Changes in the quantity of urine (oliguria, anuria, polyuria) are perhaps more variable than the so-called cardinal signs of traumatic injury of the kidney. With a history of trauma of such nature as to probably involve the kidney, changes in the quantity of the urinary output are to be taken as significant of injury to the upper urinary tract.

Complications and remote results are always to be reckoned with as possibilities in connection with traumatic injuries of the kidney. Secondary hemorrhage, suppuration, pseudohematonephrosis, hydronephrosis, intraperitoneal hemorrhage, nephritis, cysts, calculi, and perhaps malignant neoplasms, may be associated with or may follow as a result of traumatic injuries of the kidney. Wildbolz [28] collected 17 cases of traumatic hydronephrosis. Köhler [36] reported a case of floating kidney resulting from trauma; renal calculi following injury to the kidney have been reported by Casper [37] and others, and instances of the development of malignant neoplasms in the kidney subsequent to the injury have been reported by Thielhaber,[38] Beneke and Namba,[39] and Tschernning,[40] among others. In the following cases of my series movable kidney was a result of injury.

Case 7. J. C., male, aged 51 years. Previous history excludes the kidney from consideration. Two months before admission to the hospital, in an automobile accident, patient was struck in the left side by a mud-guard. He was unconscious immediately after the accident, but experienced no other trouble until two months later, when he began to have an aching and persistent pain in the left side of the back, which was relieved by lying down. These attacks were followed by the passing of large quantities of urine. There had been no change in the appearance of the urine. Examination revealed palpable, movable left kidney; right kidney apparently

normal. Cystoscopic examination and ureteral catheterization showed, when combined with X-Ray examination, a prolapsed kidney, but no other pathological condition. The symptoms were relieved by applying an abdominal belt and pad for the left kidney.

Case 8. P. W. H., male, aged 36 years. Eleven years before he came under my care, patient fell from a fire escape, striking the right side of the abdomen, midway between the ribs and the crest of the ilium. Hematuria followed the accident, and lasted four days. Since the accident he has had more or less constant dull pain just below the right costal margin. He has had no further urinary symptoms, and has been in good general health. Upon examination, a small movable mass was palpable under the right costal margin, undoubtedly the kidney. Cystoscopic examination and ureteral catheterization revealed a deficient and movable right kidney, but the urine contained no pathological elements. A pyelogram showed an obliteration of the lower calyx, and an indefinite, faint, irregular shadow, involving the lower pole of the right kidney, with no changes in the size or outline of the renal shadow,—presumably a cicatrix resulting from laceration at the time of the injury, eleven years before.

The pyelogram in this case is similar to one taken recently in which the kidney, twelve years previously, had been split and a section removed.

Diagnosis. One or more of the typical symptoms will be elicited, if carefully sought for, in the majority of cases, though, as we have seen, apparent exceptions have been recorded. With the history of a blow on the side or back, shock, pain, tumor, and hematuria, the diagnosis is plain. In the absence of tumor, hematuria will probably be present, and the investigation of this will reveal the cause.

Not all cases, however, as we have seen, are typical, presenting the classic or cardinal symptoms in such degree and sequence as to lead to a positive diagnosis of injury to the

kidney. The difficulties often increase as the time between the accident and the examination lengthens.

When the diagnosis cannot be conclusively established from the clinical signs, one or more of the various aids to diagnosis should be employed. Cystoscopy, ureteral catheterization, microscopic examination of the urine, pyelography, and radiography are to be considered in this connection.

Pyelography has been advocated by Luckett and Friedman [41] as a means whereby positive information may be obtained, and by which one may determine how much laceration has occurred to the kidney substance, whether it is an intracapsular injury, or whether the capsule has been torn through, the determining factor being the dissemination of collargol (injected through the ureter) within the kidney substance or outside of it, as shown by the radiograph. This leads to conclusions as to whether surgical interference will be imperative without waiting for secondary symptoms as an indication for such interference.

Florence and Ducuing [42] have suggested, in connection with a case in which the diagnosis was difficult, the diagnostic value of exploratory puncture of the cul-de-sac of Douglas, by way of the perineum.

Heitz-Boyer [43] made the diagnosis of traumatic nephritis by means of examination with experimental polyuria and the ascertaining of the urea normal of Auerbard.

In some cases a positive diagnosis, especially with reference to the extent of the injury, can be made only by means of exploratory laparotomy or lumbotomy. Resort to this more radical method of diagnosis should be prompt in the face of urgent symptoms the exact origin of which cannot otherwise be determined.

Treatment. After reviewing the opinions of a number of experienced observers Lüken [6] concludes that there is no uniformity in the matter of treatment of traumatic injuries of the kidney, except that all decide on operation where life

is in danger from primary hemorrhage or infection arising at the wound focus. My own review of the literature leads to virtually the same conclusion. However, whether the treatment be expectant, conservative surgical (exploration, drainage, suture, or partial excision), or radical surgical (nephrectomy), each case must be considered individually. It goes without saying that it is desirable, wherever this is possible, to leave the patient with two functionating kidneys rather than one, and where this cannot be done, to conserve as much as possible of healthy kidney tissue. Early and positive diagnosis is the most potent factor in the attainment of this end. While it is true, as many writers have stated, and as at least two cases of my series (Cases 6 and 8) seem to indicate, that spontaneous cure can and does take place, too many chances should not be taken with Dame Nature, who is apt to be rather whimsical in the application of her boasted healing power. Whether expectant treatment or conservative methods be employed, we should take care that we are not subjecting the patient to the possibility or the probability of the subsequent destruction of the kidney, in part or in the whole, from infection of the kidney substance itself or of a hematoma.

Ureter

Morris,[44] in 1884, stated that he saw no reason for considering the subject of traumatic injuries of the ureter apart from the kidney, because, as he said, "in the very few cases on record the rupture of the ureter was quite close to the renal pelvis, and it was neither practicable nor requisite from the point of view of treatment to distinguish between subcutaneous rupture of the renal pelvis and subcutaneous rupture of the ureter." He further stated that only three cases of penetrating wounds of the ureter had been published, at least one of which was doubtful. He concluded "that the diagnosis, symptoms, sequelæ, and treatment of injured ureter in no

way differed from those of ruptured or wounded kidney." His estimate of the subject at that time was based upon the records of 13 cases of subcutaneous rupture of the ureter, and three cases of penetrating wounds.

From the appearance of his earlier communication up to 1901, Morris[15] found 8 additional cases purporting to be subcutaneous injuries of the ureter. These cases, however, were not all cases of injury of the ureter proper, and they did not give him grounds for changing his opinion expressed in 1884. Because of the growing importance attached to the surgery of the ureter he considered the subject separately in the 1901 edition of his book. Of the 24 cases reviewed by him at that time, he considered only 12 as injuries of the ureter proper.

Blauel,[45] in 1906, found only 12 cases of subcutaneous injuries of the ureter. Since 1906 I have been able to locate only 7 cases, including the one given below.[45-51]

Case 9. Male, 46 years of age. The patient came under my observation in November, 1907, with the following history: Three years before he had fallen from a ladder, striking on the left side of the abdomen, the force of the blow coming unduly between the last rib and the crest of the ilium. The pain was severe, and radiated to the left groin and testicle. He vomited. He noticed no blood in the urine, but there was a diminution in the amount passed. Several days later a swelling appeared in the left side of the abdomen. This had never disappeared, and had become larger. He had had almost constant pain in the side; no chills, fever, or extreme tenderness. His general health had failed, and he had been under medical care, with no relief.

Upon admission to the hospital, physical examination was negative except for a smooth, tense, slightly tender mass, somewhat movable, in the left side of the abdomen. Examination of the urine was negative. The tumor was exposed through an oblique kidney incision. It was found to be a

hydronephrotic kidney, of three distinct lobulations. The thin cyst wall (thinned-out kidney parenchyma) was smooth on the surface. The whole mass extended from the crest of the ilium up under the ribs. It was adherent to the peritoneum and adjacent structures, and was freed with much difficulty. In freeing the lower pole of the mass it was ruptured, allowing the escape of eighteen ounces of thin, odorless, yellow fluid. The ureter was exposed, lying to the inner side of the mass. Two inches from the pelvis of the kidney the ureter presented a dense stricture. The stricture was fibrous in character, and prevented the passage of fluid from the kidney. There was no kink in the ureter. The kidney was removed. There was no evidence of injury to the kidney, of a calculus, or of a growth. The trouble, it is fair to assume, dated from the injury; the history, and the appearance at operation, clearly indicated a traumatic stricture of the ureter, with consequent hydronephrosis. The right kidney functionated perfectly throughout. The patient was under my care for six weeks, and was discharged healed and cured. He has been well since.

This case may be said to be typical, insofar as cases of traumatic injury of the ureter alone are ever so, for it is generally conceded that there are no definitely characteristic symptoms in these cases. Pain and tenderness over the loin or abdomen, the presence of a tumor, and the history of injury, may suggest rupture of the ureter, but they are likewise suggestive of injury of the kidney. Hematuria may be present in slight degree, it may be entirely absent, or it may be transient. The pain may subside after a time, and not appear again until it becomes associated with the presence of the tumor, the manifestation of which may be noted within a few days or not for several years, according to some of the writers on the subject.

There seems to be no dependable method whereby injured ureter with extravasation may be differentiated from injured

renal pelvis with extravasation. Inasmuch as the treatment is the same, this lack of differential diagnosis is of little moment.

Dumitresco,[46] in reporting a case of traumatic rupture of the ureter, considers the diagnosis as two-fold: A. The diagnosis properly so-called, depending upon whether the patient has been seen directly after the accident or not until several days after. B. Differential diagnosis, from: (1) Simple contusion in the region of the ureter; (2) rupture of the kidney and kidney pelvis; (3) rupture of the bladder.

Immediate catheterization and examination of the urine is important in establishing the diagnosis; cystoscopy will show the side injured; and ureteral catheterization will reveal the condition of the opposite side.

The management of cases of ureteral injury, like those of injury of the kidney, calls for exploratory incision if the symptoms do not promptly subside upon expectant treatment. When the exact conditions are thus determined, the treatment, of course, must be applied according to the needs of the individual case. This may consist of drainage, of suture, or repair by whatever method is preferred, of anastomosis, or of nephrectomy.

Conclusions

From a review of the literature concerning traumatic injuries of the upper urinary tract, and of the available reported cases, it may be fairly concluded:

1. That the small number of recorded cases of traumatic injuries to the kidney and the ureter, as compared with traumatic injuries in general, may be accounted for in part by the failure to make a correct diagnosis, and in part by the fact that many cases are dismissed as cured following a period of rest and expectant treatment, with temporary amelioration of symptoms.

2. That a careful "follow up" system would doubtless

throw a different aspect over many of the cases treated expectantly and dismissed as cured, as with three of my series.

3. That, in all probability, many cases of the vague symptom-complex, neurasthenia, might be cleared up by a more careful study of the history and the symptoms in relation to the possibility of traumatic injuries of the urinary system, especially the kidney.

4. That in no case, where any of the evidence directs attention to this part of the body, should too much dependence be placed in the cardinal symptoms, as to their absence or their presence.

5. That prompt and painstaking diagnosis, and the application of treatment in accordance with the exigencies of each case, will tend to lessen the mortality and the remote results of the injury, and will lead to the conservation of functioning kidney tissue in many cases in which ultimate nephrectomy would otherwise be necessary.

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LARGE SOLITARY AND MULTIPLE CYSTS OF THE KIDNEY

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SOLITARY and multiple large cysts of the kidney are surgical rarities and are of interest because of their lack of diagnostic features and because in most instances where they have been encountered, nephrectomy, rather than a more conservative operation, has been practised. Having operated upon four patients with this disease, I wish to make brief mention of them and the other clinical cases occurring at the Boston City Hospital as well as the post mortem specimens recorded at the Boston City Hospital and at the Long Island Hospital, Boston.

Speaking in general, cysts of the kidney have a large variation in size and number, and may be congenital or acquired. The acquired form is the only one that concerns us in this connection. Acquired renal cysts are usually small, multiple, and occur most commonly in kidneys which have undergone structural changes, whereby tubules have become obstructed, and urinary secretion continuing without an outlet, retention cysts result. Among the more commonly recognized renal conditions with associated cystic changes, may be mentioned chronic interstitial nephritis, arteriosclerosis, cicatrices from infarcts, deposits of urinary salt in the organ and inflammatory conditions of the renal pelvis extending to the pyramids and obstructing or obliterating the tubules. The types of cyst associated with the above mentioned condition are usually small, multiple, and the diseased condition of the kidney upon which the cysts are dependent is clinically obvious from the general manifestations and changes in the urine.

It is the cyst of considerable size, producing an abdominal tumor, and occurring in an otherwise normal, or but slightly changed kidney, which concerns us from a surgical standpoint. The relation, in origin, of the large serous cyst involving but one kidney, to the small bilateral cysts associated with marked kidney changes, just mentioned, and to congenital polycystic disease, is not clear. There is much discussion in regard to the pathogenesis of large renal cysts, which matter has been presented fully to this society by Caulk, and will not be considered here.

Large solitary serous cysts, producing abdominal tumors, are very uncommon and are probably due to some undiscovered obstruction in the uriniferous tubules and the continued excretion of urine. They are generally unilateral and are considered by those who have studied the subject to be large retention cysts.

That they are rare is seen from Morris' report of 2,610 autopsies at the Middlesex Hospital, London, in which series there are recorded five cases. In 4,250 autopsies at the Boston City Hospital and Long Island Hospital, Boston, I have been able to find but 34 instances of the type of cyst under consideration. From the literature it is found that Israel encountered but one instance in 297 surgical affections of the kidney. Simon in 1906 could find but 52 cases, and Brin in 1911 added but one more case. Aside from these series, single cases have been recorded by Récamier, Blake, Zaccarini, Sarkissiantz, and Fowler. Giuliani reported two cases, one containing blood, and the other serum, and Brockenheimer records a cyst which he removed from a horseshoe kidney.

These cysts have been more commonly found in females than in males. Albarran is the only authority who shows a slightly higher percentage in the male. Fowler, in a series, reports 22 females and 12 males, and Tuffier gives a proportion of 20 females and three males. Of the four cases which I have operated upon, one was a male, and three were fe-

males. Of the 34 autopsy cases in this report, 13 were males and 21 females.

Fowler in his series found the right kidney affected in 22 and the left in ten. In my series of 34 autopsied specimens and the four clinical cases, the right kidney was involved in 20, the left in 16, and it was bilateral in 2.

The *type of cyst* under consideration occurs in adult life; there being but one case, that reported by Wagner, which was four years of age, appearing as the exception. Simon could find but seven patients under twenty years of age. Fox records a patient 70 years old, and one of my patients was 72 years of age.

In regard to the *location of the cysts,* they are usually situated at one or the other pole of the kidney. Simon, in his series of 52 cases, found 18 at the lower pole, 8 at the upper pole and 8 in different parts of the body of the kidney. Terrier found six in the upper pole and one at the lower pole. Récamier's case showed the cyst to be at the upper pole of the kidney, but Fowler's, Blake's, Sarkissiantz's, Giuliani's (two cases), Zaccarini's and 10 out of my series of 34 autopsy specimens, were in the lower pole. Of the remaining autopsy specimens in my series 18 were in the upper pole and 6 in the body of the kidney. Of my four clinical cases, three were in the lower pole and one had cysts in the body of the kidney, as well as at both poles.

The *size of the cysts* has varied within a very wide range. Rendu records a case of a cyst containing ten litres; and Morris one which practically filled the abdominal cavity and weighed 16 pounds. One of my cases had a cyst containing over two bucketfuls of fluid. The majority of the cysts have been about the size of an orange. Rarely the cysts have communicated with one of the renal calices, but in most instances the renal surface of the cyst has been smooth, and the cyst wall of about the same thickness at the point of attachment to the kidney as elsewhere.

Case mentions a cyst of considerable size, the walls of which had undergone calcification, as was the case in one of my postmortem specimens, in which instance the cyst cavity also contained several small calculi.

The *content of the cyst* has usually been found to be of a clear, serous character, but some have been urinous, turbid, gelatinous, bloody, and caseous. The fluid usually contains albumin and urea, and colloid material has been found in some, as well as phosphates, sulphates, and chlorides. The specific gravity has been between 1,010 and 1,020.

Histological study of the free portion of the cyst wall has resulted in diverse findings. LeDentu, Terrier, Follin, and Duplay have described the wall as consisting of fibrous or connective tissue without an epithelial lining, while Lejars has observed flattened cells, and Cornil, Delkeskamp, and Babinski flattened and cuboidal cells, lining the cysts. Bonneau and Hartmann record a cyst lined with cells containing elongated nuclei resembling endothelium, in certain areas, and absent in others. Papin and also Lecène have found a cellular lining in the cysts. Hyaline changes and unstriped muscles and nerves, as well as numerous blood vessels, have also been noted. Various changes have been recorded in the renal parenchyma beneath the cyst by Terrier, who remarks that the tissue looks normal in the gross, but histologically there is evidence of nephritis. Others have found the tissue thickened and some of the tubules show a slight degree of fatty infiltration and inflammation. The microscopical study of postmortem tissue, in my series, shows that the tubules may be compressed, dilated, or distorted, with interstitial changes similar to those seen in nephritis. A study of renal tissue in many of the postmortem specimens showed these slight interstitial changes, while other areas, some distance from the cyst, were quite normal. There were occasionally sclerosed and hyalin glomeruli and thickening on the walls of the vessels. The tubules were sometimes dilated or contracted and

contained occasional hyalin casts, granular coagulum, and in some there were areas in which the epithelium was granular or disintegrated.

The *symptoms* dependent upon large solitary or multiple cysts are ill-defined, and unless there is coexisting disease, such as calculi or new growth, which produces changes in the urine and the renal function, the urine remains normal and the symptoms are most obscure. Tumors arising in the lumbar region and obviously of renal origin have been noted in some of the cases and in others the tumor has been observed, presenting not unlike a large gall-bladder or ovarian tumor, for which conditions it has more than once been mistaken. Lumbar pain has rarely been a prominent symptom, but in some of the cases in which the cysts were very large there have been pressure symptoms, and a sense of intra-abdominal weight similar to that in any intra-abdominal tumor. In the uncomplicated cases the urine has remained quite normal and the renal function unaltered. When these objective and subjective symptoms have been present, the diagnosis has usually been hydronephrosis, gall-bladder disease or an ovarian tumor.

From the *diagnostic standpoint,* a complete examination of the urinary tract by cystoscopy, ureter catheterization, renal function tests and pyelography can eliminate hydronephrosis, but in most of the cases these methods of examination have not been employed and the true condition has only been discovered at the time of operation; the operation usually being undertaken because of the presence of an intra-abdominal tumor or because of the mistaken diagnosis of hydronephrosis.

In regard to *treatment* several procedures have been practised. One can not help but feel that too often nephrectomy has been done when the kidney might have been saved. Aside from the loss of an organ with but little if any impairment of function, it is important to realize that the other kidney has not undergone a vicarious hypertrophy, because of the nature

of the malady, and is in no condition to undertake the work suddenly thrown upon it by the loss of its mate. In this connection it is of interest to note that in Tuffier's series 11 cases out of 24 died following nephrectomy. Quenu records five deaths in seven nephrectomies and Lejars seven deaths in 16 patients so treated. In instances where the cystic kidney is much destroyed, compensation will have taken place, which is easily learned by the routine preoperative study of the renal condition, and under such existing conditions nephrectomy may be the operation of choice.

In cases where there is little or no impairment of renal function, resection of the cyst, partial nephrectomy, and emptying the cyst content and sewing the cyst sac to the skin have been practised with good results.

Resection of the cyst seems to me to be the operation of choice. It has been done successfully by Tuffier, Ricard, Récamier, Albarran, and Bardenheuer, and in three of my cases. In two of my cases the sacs were incised where they joined the kidney tissue, as there was no real line of cleavage between the sacs and the renal parenchyma. The cysts could, however, be freed from the renal parenchyma by gentle traction, leaving a bleeding surface which was satisfactorily brought together by mattress sutures. In another of my cases, in which the cyst was of tremendous size, occupying the whole retroperitoneal space, the sac was simply cut away from its attachment to the lower pole of the kidney and no attempt was made to remove that portion adjacent to the renal tissue. In the fourth case nephrectomy was done because an obvious hypernephroma was present in the kidney tissue above the cyst.

Albarran and Imbert record five cases in which partial nephrectomy was successfully carried out, and Morris recommends this procedure when the renal tissue is spread out over the cyst wall.

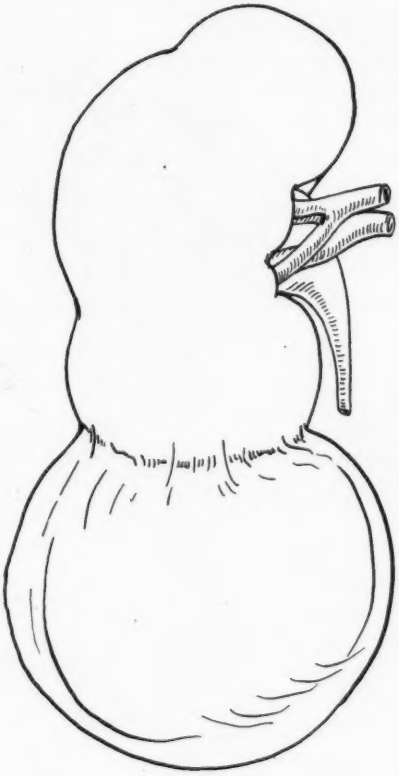
Emptying the cyst content and suture of the edges of the

cyst to the skin is the least severe operation, and is of value when the patient is in poor condition or the cyst very large. This procedure should, however, be employed only when it is not advisable to resect the sac or do a partial nephrectomy, as Tuffier records three cases out of eight in which intractable fistulæ resulted from this operation, one later requiring nephrectomy; and Morris records three persistent fistulæ out of five patients so treated. Lejars mentions seven patients treated by puncture, with three cures and four deaths, and Simon three patients with one cure and two deaths. Although my case, which had the tremendous sac, recovered, it would have been wiser, perhaps, to have employed simple drainage of the sac, without attempting to remove it, and it is in this type of renal cyst, if any, that simple drainage should be employed, in my opinion.

Case 1. Female. 58 years old. Entered the Long Island Hospital in March, 1911, with nothing in the past history of importance, except that she had attacks of jaundice which were supposed to be dependent upon gall-stones, and for which she had refused operation. The physical examination was negative, except for a slight fulness in the right upper quadrant of the abdomen which was not tender on pressure. The urine examination was negative. The patient was habitually constipated. About four weeks after entrance to the hospital the patient had a typical attack of gall-stones, associated with jaundice and clay-colored stools, and bile appeared in the urine. The usual signs dependent upon this condition were present.

Operation. A right rectus incision was made and the gall-bladder found distended. To the outer side and below it, behind the peritoneum, was a mass about the size of an orange which appeared to be attached to the lower pole of the kidney. The gall-bladder was removed, following which an incision in the peritoneum about one inch from the outer border of the ascending colon was made. The peritoneum with the

PLATE XII—Presented by Dr. J. H. Cunningham, Jr.



Case No. 1. Kidney with cyst. Cyst resected.

PLATE XIII—Presented by Dr. J. H. Cunningham, Jr.

Case No. 3. Kidney with cyst in lower pole. Hypernephroma in body of kidney and projecting into renal vein. Nephrectomy.

colon was stripped upward and inward, exposing the kidney. Attached to the lower pole there was a cyst, about the size of an orange, the walls of which contained many blood vessels. The remainder of the kidney appeared normal. The cyst was punctured, with the escape of a straw-colored fluid. An incision was made in the kidney capsule, near the junction of cyst with the kidney, and the attachment of the cyst to the kidney dissected away leaving a depressed, oozing surface, which was brought together by mattress sutures of catgut. A stab wound was made into the loin, and the retroperitoneal space drained with a cigarette drain. The peritoneal incision was united, replacing the ascending colon. The abdominal wound was closed, except for a small drain at the upper portion of the wound, running to the gall-bladder area. The patient made an uneventful recovery. (PLATE XII.)

CASE 2. Female. 72 years of age. Referred by Dr. George Muttart, with a negative past history, except that she had had pneumonia 32 years ago, and is the mother of four children. Two years ago she had what was supposed to be a gastric upset, associated with vomiting and pain on the right side, in the region of the gall-bladder. A small lump, the size of a lemon, could be felt and was supposed to be a distended gall-bladder. This is said to have disappeared in a few days, and did not return until three months ago, when the patient noticed a swelling in the region of the gall-bladder, without accompanying symptoms until a few days later, when she had blood in the urine for one day, without pain. The patient was seen by Dr. Muttart, who said that the swelling in the region of the gall-bladder was the size of a small orange and that the urine contained a small amount of blood; the examination being otherwise negative. Three months later there was an attack of painless hematuria lasting one day and the swelling in the right upper quadrant had increased in size. When seen by me, December 7, 1915, the abdomen was negative, except for a swelling the size of a small grapefruit in the

region of the gall-bladder, extending downward below the umbilicus; movable, not tender, and elevated above the surface one inch throughout the right upper quadrant. The urine was negative, being 1010, acid, and without albumin or sugar; sediment showed but a few epithelial cells. The remainder of the physical examination was negative. The cystoscopic examination showed the bladder capacity to be 12 ounces. The bladder wall and ureteral opening were normal; catheters were passed to each kidney without meeting obstruction. The urine obtained from the right side was less than from the left side, and both were normal in character. The phthalein test showed 25 per cent. from the left kidney and 5 per cent. from the right kidney in one hour. Until these findings were made in regard to the renal functions the opinion was held, by several who had examined the tumor, that it was of gall-bladder origin.

Operation. December 11, 1915, a right rectus incision was made and the abdomen opened. All the abdominal organs were normal. The tumor was retroperitoneal. The peritoneum was divided about one inch from the edge of the ascending colon and the peritoneum stripped forward toward the median line, exposing kidney, which showed a cyst, the size of an orange, at the lower pole and a tumor growth above the hilum. The mass was freed from its bed and the renal vessels and ureter identified. The ureter was clamped, tied and divided about one-half inch from the kidney pelvis. The renal vessels were tied separately, and divided. The specimen, Fig. 2, consisted of a cyst at the lower pole, unruptured, and containing a clear serous fluid and the tumor growth. Histologically, it was a papillary adenocarcinoma, probably of adrenal origin.

The peritoneal fold at the line of incision was united by a continuous catgut suture, replacing the ascending colon in its normal position. The retroperitoneal space was drained through a stab wound in the groin by a piece of rubber dam.

PLATE XIV—Presented by Dr. J. H. Cunningham, Jr.

Case No. 3. A. Kidney with multiple cysts. Anterior view. B. Kidney with multiple cysts. Superior view. Cysts resected.

The peritoneal incision was closed without drainage. The patient made an uneventful recovery. The drain was removed on the fourth day and the patient sat up on the 10th day, and left the hospital on the twelfth day. Since the operation she has been perfectly well. (PLATE XIII.)

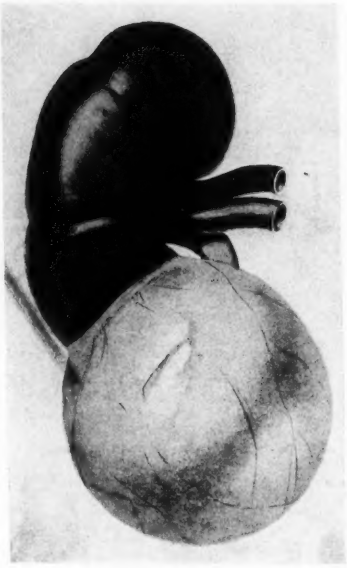
CASE 3. Male. Physician, 63 years of age. Referred by Dr. T. Chittendon Hill, February 9, 1909, with a past history of having passed uric acid calculi twenty years ago, and during the subsequent ten years, there being five attacks in all. Ten years ago the pain became so severe in the left lumbar region that he was obliged to give up his practise. He consulted many prominent men in England and on the Continent, as well as in this country. The general opinion was held that he had an excess of uric acid and a uric acid diathesis. All X-ray plates of the kidney region were negative, as well as several cystoscopic examinations. The pain in the left lumbar region persisted, and when seen by me he was stooped over, in which position he carried himself constantly, on account of the persistent pain, and it was only by the use of morphia that he could get about. The physical examination showed him to be obese, with a moderate arterial sclerosis, but the general condition was otherwise negative. Locally, the external genitals were normal. Neither kidney region was tender and neither organ could be felt.

The urine was clear; specific gravity of 1015, strongly acid, and without albumin. There was no visible sediment and the microscopic examination showed a few abnormal and normal blood corpuscles and an occasional leucocyte; many uric acid crystals. Cystoscopic examination and ureter catheterization revealed nothing abnormal. Indigocarmin test equal on both sides and quite normal. An X-ray examination by Dr. Percy Brown showed the kidney to be increased in size and a concretion of irregular shape in the pelvis of the left kidney.

Operation. Charlesgate Hospital, February 20, 1909. Lum-

bar incision. The perirenal fat was abundant and tough, suggesting an old chronic process. As the fat was separated, a cyst, bluish in color, with vessels running everywhere over its surface, came into view. It was the size of a large orange, originating from the lower pole of the kidney. This cyst was tapped and a clear straw colored fluid escaped. The sac was opened and the base was found to make a depression in the kidney about one and one-half inch in diameter and to sink into the kidney about three-fourths of an inch. The fat was freed from the superior pole of the kidney, where another cyst, similar in character, and the size of a large lemon, was found. This cyst was also tapped and dealt with in the same manner. On freeing the anterior surface of the kidney, another cyst of the same character, the size of a small lemon, was found and treated in the same manner. A small cyst the size of a Concord grape was found situated between this last cyst and the cyst at the upper pole. This was ruptured and contained the same kind of fluid as the others. The stone could be felt in the pelvis of the kidney from the anterior surface. In freeing the posterior surface of the kidney another cyst, the size of a large lemon and with the same characteristics as the others, was found and dealt with. It was impossible to reach the pelvis of the kidney posteriorly, as the kidney could not be delivered on to the loin. The stone was reached by boring through the bottom of the cyst on the anterior surface, and removed with difficulty, the stone being firmly adherent. The walls of the cysts, about two or three mm. in thickness, bled freely from their cut edges. Each cyst in turn was cut away from the kidney substance and the oozing depression obliterated by mattress sutures of catgut. After obliterating these cyst areas with the sutures, all bleeding was controlled and a small gauze wick was placed over the pelvis of the kidney on the anterior surface, and a similar one to the same point on the posterior surface. The muscles were united by a continuous chromic gut suture,

PLATE XV—Presented by Dr. J. H. Cunningham, Jr.



Case No. 5. Case of Dr. J. B. Blake's. Resection of cyst.

and the external wound by interrupted silk-worm gut sutures around the wick. Under ether the right kidney could be palpated, somewhat larger than normal. The stone was shaped like an Indian arrow head, dark brown in color, and covered with small spines. (PLATE XIV.)

The patient made an uneventful recovery and the urine has remained normal up to the present time, except for the presence of uric acid crystals. The patient has all the manifestations which go with a severe uric acid diathesis. Changes have taken place in the spine for which he has been under the care of an orthopedic surgeon.

CASE 4. Female. Nurse at Long Island Hospital. Age 29 years. Presenting nothing of interest in the past history. In the *early part of the winter of 1906* she complained of a sensation of fulness and a swelling in the right upper portion of the abdomen. An examination in November showed a tumor the size of a grapefruit, and elevated about two inches above the surface, the center of which was about on the level of the umbilicus. There was a sensation of fulness extending beyond the mid-line, well onto the left side, and downward to the brim of the pelvis. The only tympany, by percussion of the abdomen, was in the stomach area and in the left flank. Aside from a slight diminution in the 24-hour amount of urine, nothing abnormal could be found in the remainder of the examination. It was believed that the tumor was probably an ovarian cyst; an operation was advised, but refused. She continued her duties and refused examination until the early part of *January, 1907,* when it was found that the tumor had increased in size so that it resembled an eight months' pregnancy. There was nothing else abnormal in the examination, although she had complained of constipation. The sense of fulness in the abdomen and the difficulty in defecation led her to consent to operation.

Operation. Jan. 14, 1907. A median incision extending from the umbilicus downward almost to the symphysis. In-

spection showed that the pelvis could not be entered and that the tumor mass was behind the peritoneum. The incision was extended upward, almost to the ensiform. Through this extensive incision the inspection of the abdomen showed that the peritoneum had been elevated almost to the abdominal parietes, and that all the small intestines had been crowded to the left side of the abdominal cavity. The stomach had been forced upward and the transverse colon was so flattened by retroperitoneal pressure that it could hardly be distinguished, and was only recognized by the striæ. The retroperitoneal mass occupied the whole retroperitoneal space from beneath the liver, downward, filling the pelvis, and was more prominent on the right side than on the left. An incision was made parallel with the tranverse colon, about one inch above the superior border, which brought the incision about the midpoint of the abdominal cavity. The peritoneum was stripped upward and the cyst tapped, with the escape of over two bucketfuls of a blood-tinged serous fluid. The sac was then separated from the peritoneum in front and could be freed entirely from the left side of the abdomen, but was fixed at the lower pole of the right kidney, where it formed a sac-like insertion at the lower pole. The sac was divided at this point, and the dissection carried downward, separation being easy until the brim of the pelvis was reached. The sac could not be separated from the sigmoid or lateral walls of the pelvis. In order to have freer access to the pelvis an incision parallel with the transverse colon at a point one inch below its inferior border was made, but the pelvic portion of the sac could not be removed; the sac was therefore cut off slightly above the brim of the pelvis, purse stringed, and brought to the lower portion of the abdominal wound, where it was sewed to the peritoneal edges of the transverse colon, and caught to the psoas muscle by four interrupted catgut sutures; thus closing the retroperitoneal space and fastening the peritoneum to the underlying structures. The abdomen

was closed, except for a space at a point over the transverse colon where a large wick was placed, and for the area where the saw was brought to the surface at the lower end of the wound.

Dr. S. B. Wollbach, at that time pathologist at the hospital, witnessed the operation, and was of the opinion that the cyst was of renal origin and possibly due to some congenital defect. The remainder of the right kidney appeared normal, as did the left kidney which could be easily seen and palpated. Dr. Wollbach examined the sac and found it to be fibrous tissue, with an epithelial lining, of a character that gave further evidence that it was of renal origin.

The patient made an uneventful recovery for eight days, when a fecal fistula developed in the drainage area. On the fourteenth day a piece of gangrenous intestine presented in the wound, which was drawn out and found to be the transverse colon. This piece of gut measured fourteen inches and apparently sloughed out from lack of blood supply, as we had feared it might at the time of operation. The patient continued to improve in general condition and feces to escape freely through the wound.

Six weeks following operation, and while consideration was being given to the method of reestablishing the continuity of the intestinal canal, the patient had a movement by rectum. Movements by rectum continued to take place and the fecal discharge from the wound began to decrease, and at the end of twelve weeks there remained but a small sinus from which a sero-purulent material escaped, and all the feces were passed per anus. The sac had previously become obliterated, having been treated by occasional injections of iodine.

The patient left the hospital in fairly good condition and returned to her duties as a nurse on July 29, 1907, and graduated in January, 1909, in excellent condition, except

for a small persisting sinus which required daily dressing. The bowels moved naturally without cathartics.

The patient made frequent requests for an operation which would cure the sinus. These were persistently refused, and on her own initiative, without my knowledge, she consulted Dr. John T. Bottomly, who undertook the task, at the Carney Hospital, on March 20, 1909. The patient died three days later of a general peritonitis. There was no postmortem examination.

Case 5. Patient of Dr. J. B. Blake. Female. Age 32 years. Complained of a movable tumor in the abdomen, which she had had for three years. There was a history of a severe constipation for many years and the loss of weight and strength during the past six months. Physical examination showed a rounded, movable tumor in the abdomen, below the liver, not tender and resembling a grapefruit in shape and consistency. The urine contained a slight trace of albumin and a few hyalin and granular casts. Physical examination was otherwise negative. Cystoscopy and catheterization of the ureters showed a urine normal in amount and character on the right side and diminished on the left side.

Operation. Through the lumbar route; showed a kidney with a translucent, yellowish, thin walled cyst, the size of an orange, originating in the lower pole of the kidney. The cyst was emptied and excised. The bleeding from the cystic area was overcome by overcasting the edges with catgut sutures. The kidney was replaced in its normal position, the wound drained and the patient made an uneventful recovery. (See Plate XV.)

Case 6. Female. 70 years of age. Entered the Boston City Hospital, January 16, 1909, with a severe pain in the right upper quadrant of the abdomen, shooting to the right shoulder. There was nausea, vomiting, a high temperature and leucocyte count. The physical examination showed

marked tenderness and spasm in the right upper quadrant in the region of the gall bladder.

Operation. By Dr. F. B. Lund, who found the gall-bladder involved in a mass of acute inflammatory adhesions with an abscess between it and the liver containing about four ounces of pus and a gall-stone. The area was drained. The urine before and after operation was normal. The patient developed a facial erysipelas and died Feb. 3, 1909, of sepsis.

Autopsy. Showed in the left kidney a cyst 5 by 5 cm. in the upper pole. The content of this cyst was a clear amber fluid. There was no other gross change in the kidney. A microscopical examination of the kidney tissue showed slight chronic interstitial nephritis, and the same in the right kidney.

Case 7. Male. 70 years of age. Entered the Boston City Hospital, May 23, 1904, with symptoms of typical coronary sclerosis. Other than the changes in the circulatory system and urine of chronic diffuse nephritis, there were no abnormal signs in the physical examination. The patient died May 27, 1904.

Autopsy. Showed in the left kidney, lower pole, a cyst the size of an orange, and the content a clear yellow fluid. There were no other gross changes in the kidney. The right kidney showed a cyst the size of a large plum, also in the upper pole, with no gross changes in the kidney. Microscopical examination showed a moderate, chronic, diffuse nephritis.

Case 8. Male. 53 years old. Entered Boston City Hospital, July 23, 1906. The case was one of typical lymphatic leukemia. The only complaint was weakness. The spleen was palpable and the blood changes characteristic; the urine was of low specific gravity, but otherwise normal. The patient died July 26, 1906.

Autopsy. Showed a cyst the size of a large lemon in the upper pole of the right kidney. The content was a dark liquid. Microscopical examination of the renal tissue showed

a few areas of lymphocytic infiltration in the capillaries of the pyramids.

Case 9. Male. 77 years of age. Entered the Boston City Hospital March 9, 1896, died of cardiac disease March 22, 1896, without symptoms referable to the urinary system, except that the 24-hour amount of urine was diminished and had the characteristics of a mild interstitial nephritis.

Autopsy specimen showed a cyst the size of a fist in the upper pole of the left kidney. Microscopical examination of the renal tissue showed a chronic interstitial nephritis.

Case 10. Male. 56 years of age. Entered the Boston City Hospital, July 20, 1896, with a severe cardiac disease from which he died in a few days. The physical examination failed to reveal anything in connection with the kidneys, except that the urine was that of a mild interstitial nephritis.

Autopsy. Showed a cyst the size of a small orange in the lower pole of the right kidney. The gross appearance of the kidney was otherwise negative and the microscopical examination showed a mild interstitial nephritis.

Besides the autopsy findings enumerated there appear 29 instances of solitary cysts of the kidney among the autopsy records of the Boston City Hospital and Long Island Hospital. These cysts are in most instances relatively small, but correspond in every detail of character to the large ones. In all but five instances there was found some histological change in the interstitial tissue of the affected kidney. In the five exceptions, the kidneys were histologically normal.

The list of specimens of the smaller cysts are tabulated below:

1. Cyst 2.5 x 3cm. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
2. Cyst 3 x 3cm. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
3. Cyst 3 x 4cm. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
4. Cyst containing 10 cc. Right, middle, anterior, content serous, histology, slight interstitial nephritis.

5. Cyst 1.5 x 2cm. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
6. Cyst 1.6 x 2cm. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
7. Cyst 2.6 x 2.5. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
8. Cyst 4.5 x 4cm. Right kidney, lower pole, content serous, histology, slight interstitial nephritis.
9. Cyst 3 x 3.5cm. Right kidney, upper pole, content serous, histology, slight interstitial nephritis.
10. Cyst 1.5 x 1.5cm. Right kidney (mid-anterior, walls calcareous and containing small calculi), histology, slight interstitial nephritis.
11. Cyst 3 x 2.5cm. Left kidney, lower pole, content serous, histology, slight interstitial nephritis.
12. Cyst 3.5 x 2.5cm. Left kidney, upper pole, content serous, histology, slight interstitial nephritis.
13. Cyst 3.5 x 2.5cm. Left kidney, lower pole, content serous, histology, kidney normal.
14. Cyst 4 x 3cm. Right kidney, upper pole, content serous, histology, kidney normal.
    Cyst 4 x 3cm. Left kidney, lower pole, content serous, histology, kidney normal.
15. Cyst 2.5 x 3.5cm. Right kidney, upper pole, content serous, histology, communicating with pelvis.
16. Cyst 4 x 5cm. Right kidney, lower pole, calcareous walls, histology, old infarcts.
17. Cyst 2 x 3.2cm. Right kidney, greater curvature, content serous, histology, moderate interstitial nephritis.
18. Cyst 5cm. Right kidney, upper pole, content serous, histology, moderate interstitial nephritis.
    Cyst 50cc. Left kidney, lower pole, content serous, histology, old infarcts.
19. Cyst 5cm. Right kidney, upper pole, content serous, histology, slight interstitial nephritis.
20. Cyst 5cm. Left kidney, upper convex border, content serous, histology, slight interstitial nephritis.
21. Cyst 35cc. Right kidney, anterior surface, content serous, histology, slight interstitial nephritis.
22. Cyst 5.5 x 6cm. Right kidney, upper pole, content serous, histology, slight interstitial nephritis.
23. Cyst, Size of ½ kidney. Left kidney, lower pole, content serous, histology, slight interstitial nephritis.
24. Cyst 7cm. Right kidney, mid-anterior, content serous, histology, slight interstitial nephritis.
25. Cyst, Size of English walnut. Right kidney, upper pole, content serous, histology, normal.
26. Cyst, Size of Lemon. Right kidney, lower pole, content serous, histology, normal.
27. Cyst 7 x 6.5. Left kidney, lower pole, content serous, histology, normal.
28. Cyst, Size of Egg. Right kidney, upper pole, content serous, histology, moderate interstitial nephritis.
29. Cyst, Size of Lemon. Right kidney, upper pole, content serous, histology, moderate interstitial nephritis.

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CLINICAL DATA WITH POLYCYSTIC KIDNEY

By William F. Braasch, M.D., of Rochester, Minn.

UNTIL recently the clinical diagnosis of polycystic kidney has been regarded extremely difficult and the occurrence of the disease rare. The majority of cases have been discovered at necropsy and reported from the records of large general hospitals. However, with increased knowledge and with the aid of recent methods of clinical examination, the condition is no longer looked upon as infrequent and may be recognized often clinically. This is particularly true in surgical clinics where patients with surgical complications of polycystic kidney seek relief.

According to the records of the Mayo Clinic up to May 1, 1916, forty-one patients had been operated on who, on exploration, were found to have polycystic kidneys. Twenty-six of these were recognized clinically.

Occurrence. Kidd divides the course of the disease into 3 stages:

1. The latent stage necessarily occurring in the young adult and usually discovered only in the course of general abdominal exploration.

2. The stage of renal tumor and hematuria (usually found in surgical clinics in patients at middle adult life) and

3. The uremic stage (more commonly seen in the general hospital or medical clinics).

The early age of the majority of the patients in this series emphasizes the fact that polycystic kidney is usually discovered on surgical exploration in either the stage of latency or the stage of surgical complication. Only cases of the adult

type have been included since no case occurring in infancy was observed which could be regarded as surgical. Although the average age was 46 years, ten patients (25 per cent.) were below 40 years of age. One of the two who were below 30, was only 18. On the other hand, 7 (17 per cent.) were 60 years or more, showing that because of an unusual degree of resistance, the condition may not be recognized until surgical complications cause subjective symptoms. No material difference in occurrence as to sex was noted. In regard to hereditary tendencies, the records are not complete, but definite evidence that heredity has an influence was noted in several instances. In one patient a history of cystic kidney was ascertained for two preceding generations.

Subjective Symptoms

The predominant subjective symptoms usually are pain, hematuria, tumor and such symptoms as result from diminished renal function.

Pain. Unless interference with urinary drainage or widespread infection occurs, the pain is not severe in character. Occasionally, however, a dull ache is referred to either loin, usually unilateral, which may be explained as due to an increase in the size of the cysts, which causes either pressure or increase of intra-renal tension. Interference with drainage resulting from blood clots, lithiasis and ureteral obstruction may be the cause of severe colic and mask the underlying condition.

Hematuria. Hematuria occurred in sixteen cases (40 per cent.). It was usually profuse and continued over periods of from several days to several months. In 6 cases, it was described as occasional, and in 8 as continued over a period of months. Hematuria is evidently caused by rupture of small blood vessels in cysts, and the blood appears in the urine only when one of the cysts ruptures into the renal

pelvis. With a recent history of hematuria, large cysts filled with dark bloody fluid, or degenerated blood-clots of various hues may be found on surgical exploration. Hematuria is usually stopped by puncture of the blood-distended cysts. The severe colic frequently accompanying the condition is caused as a rule by clots, although over distention of the cysts may also be a factor. Intracystic hemorrhage may be present without hematuria.

Evidence of renal insufficiency. The clinical symptoms and data in cases of polycystic kidney in the stages of renal insufficiency may resemble those occurring in interstitial nephritis to such a degree that it has been argued the two conditions are practically identical. When clinical evidence suggests interstitial nephritis in young adults, it is advisable to examine carefully for evidence of bilateral renal enlargement. However, the clinical symptoms of renal insufficiency with polycystic kidney differ in many respects from those occurring with nephritis. In most instances the first evidence of renal disturbance and occasionally the only evidence during a period of several years, is nausea and vomiting. It was present in 6 of the 9 patients showing other clinical evidence of renal insufficiency. Cardiac disease occurred but infrequently, and is evidently a terminal complication. None of the patients had edema of the extremities.

Blood Pressure. Blood pressure records were available for but 16 patients; it was normal in 7. In the remaining patients the systolic blood pressure was variably increased. In one case it rose as high as 240, and the diastolic pressure as high as 180. Two of the four patients with a systolic pressure of over 200 died as a result of operation. The question may well be raised whether any operation will materially influence or permanently reduce a very high blood pressure. In three of the patients with high blood pressure examined subsequent to operation the blood pressure was decreased but little. An extremely high systolic and diastolic blood pres-

sure with a specific gravity as low as 1003 or 1004 and but a trace of phthalein, contraindicates even a Rovsing operation.

Urinary data. The specific gravity in 17 of the 41 cases was 1015 to 1031; in 14 cases, 1010 to 1015; in 9 cases, below 1010.

Low specific gravity and polyuria are to be expected with polycystic kidney in the stage of present or impending renal insufficiency. In other stages it is not necessarily present and a normal specific gravity does not exclude polycystic change. It is of interest that all but one of the patients with a specific gravity below 1010 have been reported dead, and these constitute all of the deaths so recorded in the entire series. A low specific gravity is, therefore, of considerable prognostic importance.

Phthalein estimate. A phthalein estimate was made for eleven patients. In five it was found to be from 40 to 73 per cent., in two, 30 to 40 per cent., in two, 29 and 22 per cent. respectively, and in two only a trace. The two latter patients died following operation. A normal phthalein as well as a normal specific gravity is present frequently with polycystic kidney and does not exclude the condition. A trace of phthalein return in two hours usually excludes a Rovsing operation and warrants nephrectomy only in exceptional conditions. The phthalein excretion and specific gravity were parallel with but few exceptions. In one case the specific gravity was 1020 and the phthalein 29 per cent. The phthalein test is of even more value, however, in differential functional estimates in determining which of the two kidneys has the greater functional capacity. It is of interest that a difference of several degrees in functional activity was usually noted in the two polycystic kidneys even when otherwise normal.

Microscopic data. In all but 10 of the 41 patients either red blood cells or white were present in the urinary sediment. In several instances microscopic blood cells were found where there was no history of gross hematuria. However, it is not

true, as has been claimed, that red blood cells are always present. The large number of cases in which there is a small amount of microscopic pus is noteworthy. This may be explained as being due to infection from insufficient drainage from the calyces and pelvis as the result of cystic deformity. Casts were reported present in but 5 cases; they were described as hyaline and occurred only sparingly.

It is noteworthy that the ophthalmoscopic examination was negative in every case.

Tumor. Renal tumor was noted in 31 of the 41 patients. In 3 patients the enlarged kidney was mistaken for tumor of the liver or gall-bladder. In 6 patients the condition was first discovered at operation performed for other abdominal conditions. It may be inferred, therefore, that polycystic kidneys do not cause recognizable renal enlargement on either side. Renal tumor was described as bilateral in but 18 of the 31 tumors palpated, showing that in a large percentage of cases but one kidney is definitely determined to be enlarged on abdominal palpation. Because of this, error in diagnosis is frequently made, the inference being that the condition is unilateral. Particularly is this true when there is a surgical complication in one kidney increasing its size or directing the clinical examination to the affected kidney. It is obvious that a diagnosis of unilateral polycystic kidney based on physical examination and without corroboratory data has no exact value.

Pyelography. As might be expected, the cystic transformation of the tissues about the renal pelvis has considerable influence on its outline. There is recognizable deformity of the pelvic outline in more than 50 per cent. of polycystic kidneys. The evidence of abnormality is characterized by (1) flattening and obliteration of one or more major calyces, (2) retraction and broadening of the various major calyces, (3) elongation or rounding of the true pelvis, and (4) displacement of the pelvis from its usual position and angle. The

retraction of the calyces differs from that occurring with neoplasm in that they are broadened instead of narrowed as in the latter condition. Inflammatory dilatation is differentiated readily by the absence of pus in the urine as well as by the absence of clubbing in the calyx terminals. The possibility of retention of the injected medium because of imperfect urinary drainage which is frequent in polycystic kidney must be remembered. For this reason simultaneous bilateral pyelography should not be employed. Unnecessary ureteral catheterization of the polycystic kidney is also to be guarded against because of the ease of infection resulting from the faulty drainage. As a precautionary measure the injection of a solution of silver nitrate is usually advisable before the ureteral catheter is withdrawn.

Surgical Treatment

The forms of operative procedure were as follows:

1. *Nephrectomy, 14 cases.* The various reasons for operation were: (a) Tumor with complete cystic degeneration and areas of necrosis in 4 cases; (b) lithiasis, unilateral, in 3 cases; (c) diffuse infection in 3 cases; (d) hematuria with complete cystic degeneration, in 2 cases; (e) traumatic rupture in 1 case, and (f) hydronephrosis in 1 case.

One patient died as the direct result of the operation. Ten of the 13 patients were traced; all were alive except one who died of pelvic malignancy three years after the nephrectomy. Of the 10 living, 2 were operated on one year, 2 two years, 2 three years, 3 four years, and 1 ten years ago. The good results following nephrectomy are remarkable and demonstrate very clearly that nephrectomy can be performed if the function of the remaining kidney warrants it. Nephrectomy was indicated in the cases of hematuria because of marked cystic change and areas of tissue-necrosis. When there was infection, the process was so widespread that little secreting

tissue remained and systemic toxemia resulted. In one case a moderate degree of infection was found in the other kidney as well but not enough to interfere markedly with its function. Infection is evidently the result of incomplete urinary drainage resulting from the cystic change. The stones were multiple in all of the cases of lithiasis, and were scattered in various parts of the kidney. They were of the phosphatic type and probably secondary to imperfect urinary drainage.

2. *Exploration for unilateral renal lesion—5 patients.* Before the value of the Rovsing operation was recognized two of these patients were explored for unilateral tumor. With the others, either abdominal complication or evidence of renal insufficiency prevented further operation. One patient died two weeks later as the result of the exploration; two others died within two years after operation.

3. *Polycystic kidney discovered on surgical exploration in the course of operation for other abdominal diseases—8 patients.* In this group the disease was in the latent stage and in 5 patients had given no clinical evidence of its existence. In 3 it was masked by other conditions existing in the abdomen and was overlooked clinically.

4. *Rovsing operation.* The Rovsing operation was performed on 10 patients; in 7 the condition was recognized clinically prior to operation. Two patients died as the result of the operation, and one, three years following. Of the remaining 7 reported alive, 4 were operated on during the past year, one 2 years ago, one 3 years ago and another 5 years ago. Four of this number were operated on because of persistent hematuria. Recent recurrence of hematuria was noted in one patient operated on 2 years ago. Two patients were operated on with a view to improve the renal function which was markedly reduced, one of whom died 3 days after; the other was reported improved 1 year later. The remainder were operated on because of renal tumor exploration.

As the result of operation the kidney becomes greatly re-

duced in size, but that it may subsequently increase in size was proved in a patient examined two years after operation. Therefore, punctured cysts may either regenerate or others so small that they are disregarded at operation may increase in size, although as a rule, not to the original extent.

5. *Operation or treatment for other lesions—4 cases found at postmortem.* Three of these patients died at the hospital of surgical complications following operation for various abdominal complaints. The cystic disease was not advanced and was evidently in the latent stage since there were no clinical data which might lead one to suspect polycystic kidney. One patient reached the Clinic in a semi-comatose condition, dying several days later with uremic symptoms. The condition was discovered at necropsy.

6. *Patients on whom no operation was performed.* Twenty-one cases were observed in which the clinical diagnosis of bilateral kidney was evident, but because they were not explored surgically and definite proof was lacking, they are not included in this report. Of this number 11 showed such unmistakable evidence of marked renal insufficiency that operation was not believed advisable. The majority of the group represents the advanced stage of the disease and the diagnostic data necessarily differs markedly from those regarded as surgical. The presence of bilateral cystic tumor, high blood pressure, low specific gravity and reduced phthalein return, together with a history of gastric disturbance and hematuria hardly leave the diagnosis in doubt.

In conclusion it may be stated that when renal function is reduced to the extent that the patient shows marked clinical evidence of chronic toxemia; when the blood pressure is increased as high as 200 or more; when the various renal functional tests, such as absence of phthalein return or marked increase in blood area, show marked renal disturbance, any operation is attended with considerable danger and is of questionable value. When, however, there is evidence of but a

moderate degree of renal insufficiency, the Rovsing operation is often followed by considerable benefit. It is particularly indicated in the presence of larger cysts which frequently cause mechanical pressure on the adjacent tissues. The operation is also valuable in checking otherwise uncontrollable hematuria, but it does not always have a permanent influence.

Nephrectomy is indicated only in the presence of widespread infection, persistent hematuria and destruction of renal tissue as the result of mechanical obstruction or lithiasis or other complication. It is of course possible only after the function of the remaining kidney has been demonstrated to be satisfactory. Functional tests are of particular value when the surgical kidney has caused marked systemic symptoms not easily differentiated from those caused by insufficiency in the remaining kidney. Whether or not the condition is unilateral in certain rare instances is not of great practical importance, since surgical treatment is feasible as long as the function of one kidney has been demonstrated to be good even if it is polycystic. Whether or not a nephrectomy is permissible may usually be ascertained from the general clinical picture, cystoscopic examination and functional test of the opposite kidney.

DISCUSSION

Dr. B. S. Barringer, New York: I would like to suggest one point in regard to what Dr. Braasch brought up in his paper, because I think it is a point which is not generally understood by urologists nor even by medical men, and that is the question of high blood pressure and the ease with which in many cases it may be reduced by very simple means, particularly if the patient is fat. I think I have had at least five cases in the last six months in which I have reduced the blood pressure twenty to seventy points in a few weeks. The method is perfectly simple. Reduce the patient's weight. I use the von Noorden diet for reduction and let the patient take off ten or fifteen pounds, and he will almost invariably, particularly if he be overweight, have a reduction of blood pressure of from twenty to forty points. If in addition he increases his normal amount of exercise I believe it helps. In fact, exercise is the only means by which you can reduce the blood pressure in a lean patient. I believe all of these patients with a high blood pressure should be put on a preoperative course of reduction, and I think we will all be astonished what a little taking off of weight and increased exercise will do in reducing the blood pressure.

Dr. William E. Lower, Cleveland: I am very much interested in the hereditary factor in these cases of polycystic kidney, and I would like to inquire of Dr. Braasch if he has noted this phase of it in his cases. In two of my cases I have found this factor. In one instance there were five other cases among the relatives of the patient; in another, two brothers had polycystic kidney. I think it is important to remember that this may be a hereditary condition and that other members of the family may also have polycystic kidney. I remember one case in particular where the younger brother of a patient complained of pain in the upper abdomen. An exploratory operation was made for a supposed duodenal ulcer. The operation revealed bilateral polycystic kidney.

Dr. Cunningham (closing): I would like to speak of an autopsy specimen of unilateral polycystic kidney, recovered about one week ago at the Boston City Hospital, illustrated by this photograph. Unfortunately we have no picture of the normal kidney on the op-

posite side, and you will have to take my word as to its being normal. The specimen is from a man 61 years of age, who died of syphilitic endaortitis and pneumonia. Many urine examinations showed a specific gravity of between 1006 and 1024 and a slight trace of albumin, some large and small round cells, squamous epithelial cells and no casts. The patient had no symptoms referable to the cystic kidney, nor was it suspected until found in autopsy. Unilateral polycystic kidneys are quite rare. Lejars found but 2 unilateral cases in 63 autopsy records of the disease, and Seiber in a series of 149 cases of polycystic kidney found but 9 to be unilateral. In connection with the bilateral cases I have observed 3 patients operated on by the Rovsing method by Dr. F. B. Lund, with whom I am associated at the Hospital. These cases showed much improvement following the operation and left the hospital with a much better urine than at the time of entrance. Dr. Lund has recently told me that 2 of the cases are still living and one dead, all having lived over a period of two years.

Dr. Braasch (closing): Although the Rovsing operation is unquestionably of value with polycystic kidney in selected cases, I have endeavored to emphasize the danger of operating on patients who are in a uremic condition. The Rovsing operation is indicated only when there is a moderate degree of renal insufficiency present, and not when the patient is uremic. The phthalein test is of value in determining whether or not operative treatment is advisable.

In regard to the hereditary factor, a history of renal disease in preceding generations was present in a number of cases. However, my data are not sufficiently complete to make an exact statement. Among the patients observed recently a considerable number had a history of family kidney disease. In one instance there was a definite history of three generations that had kidney disease, and in the last generation there was distinct evidence of polycystic disease.

Dr. Hugh H. Young, Baltimore: I would like to ask Dr. Braasch whether in the study of these cases they have come to any conclusion as to whether the operation ought to be done on both sides at the same time, or whether it would be desirable to operate on one side at one time and later operate on the other side; and whether in attacking the cysts it is sufficient simply to puncture the cysts, or to open them with scissors, or whether to use a cautery in order to prevent the

reclosure of the opening; and what experience they have had in cases they have gotten autopsies on as to the recurrence of these cysts themselves or the development of other cysts, and as to the improvement in the functional test.

DR. BRAASCH (closing): In regard to the operative procedure, we have merely employed a simple puncture of the cysts, with rubber tissue drainage.

As far as the results are concerned in regard to improvement of the phthalein returns, this series reported were peculiar in that many of them had no lowered phthalein in the first place. With two patients who had a moderate degree of renal insufficiency the phthalein improved markedly as a result of the operation, going in one instance from 20 per cent. to 38 per cent. as a result of the operation. This was, of course, in connection with general physical improvement, gain in strength, weight, appetite, etc. In another case the phthalein test almost doubled its figures, going from 30 up to 50 per cent. after operation. From this we can well infer that the operation improves the renal function.

We have been conservative in regard to the bilateral operation. We have had an unfortunate experience with bilateral operations. In our series the Rovsing operation was done unilaterally only in eight of the cases, bilaterally in two, for the reason that the symptoms were usually relieved by the unilateral operation and on account of the difficulty of controlling the patients subsequently.

In regard to the hematuria the operation will usually control it, probably permanently in the majority of cases, although in one case it did not. In one case there was a distinct recurrence of the renal enlargement noted two years following operation, although not to the original degree.

DR. O'NEIL: Did you make any particular choice of anesthetics in these cases? Have you ever done any under local anesthesia?

DR. BRAASCH: That brings up, of course, the old question of anesthesia, and it is one that we are biased on. We use nothing but ether in all renal cases, and we regard it as quite satisfactory.

THE ETIOLOGY AND PATHOLOGY OF NON-TUBERCULOUS RENAL INFECTIONS

By Hugh Cabot, M.D., and E. Granville Crabtree, M.D.,
of Boston

WHILE it is almost literally true that a satisfactory comprehension of the diseases of the genito-urinary tract depends upon a clear appreciation of the nature and probable course of renal infection, there is no subject in which there is so little uniformity of opinion, and so much confusion. The literature of the subject is stupefying both in quantity and in complexity, and any one who has attempted to master it will, we think, be convinced of the fact that it is more likely to confound than to enlighten the reader. Not a little of the confusion arises from a somewhat inaccurate use of terms. Thus, the great majority of writers using the term "ascending renal infection" mean a process which ascends from the lower to the upper urinary tract, but Mallory has for some reason seen fit to use the term to mean ascension from the renal pelvis into the kidney substance and has confused without enlightening. The phrases "metastatic, embolic, hematogenous, blood-borne," have been used with a looseness which defies comprehension, and finally, the persistent description of various stages in the same process as different pathological entities has rendered confusion worse confounded. Not the least serious difficulty has arisen in the almost entire failure of collaboration between the clinician and the pathologist. Thus 20 years ago Orth showed a very interesting understanding of the etiology of renal infections which the clinicians have apparently largely overlooked. On

the other hand, as in the ancient history of renal tuberculosis, the pathologist has wrought havoc with an understanding of this subject because his opinions have been based considerably upon post mortem material, which, it might be suggested, is likely to represent fatal cases, and has therefore jumped to the conclusion that a given type of lesion is generally bilateral, whereas in fact it is bilateral only in the fatal cases.

A more or less intimate association with the subject of these infections early impressed us with the complexity of the picture which may be presented by kidneys which are the site of long standing infection. It is not rare to find kidneys showing the evidences of at least three infections differing in point of time and often in the nature of the organism involved. That these should present to the pathologist a situation almost too complicated for satisfactory solution is not surprising and we have come to believe that many of them can be interpreted only in the light of considerable knowledge of the clinical history coupled with great familiarity with renal pathology. In the attempt to solve the intricate problems of renal infections much assistance has been rendered by the use of animal experimentation and yet it has in some hands led to wholly erroneous conclusions which have done considerable damage, the error arising very largely from the attempt to draw conclusions from the effect upon animals of organisms whose behavior is very different from that which they exhibit in the human body. Thus, the colon bacillus rarely produces suppurative lesions of the kidney in man, while in animals it may readily do so, and this has given rise to the quite erroneous assertion that the colon bacillus commonly, or even regularly, produces abscesses of the kidney. Where so much turns upon the exact nature of the lesion produced, a study of the lesions in animals must be surrounded with every precaution if the conclusions are to have validity. Our experience has led us to the conclusion that it is wholly unsafe to use the same organisms commonly found in human renal in-

fections in carrying out animal experiments and we incline to the view that the safest procedure is to select organisms which produce similar lesions in other organs and reason from parallel rather than from identical lesions. In studying this subject we have come to regard it as important to consider the lesions produced by various organisms upon kidneys previously normal in order to get a clear understanding. It has seemed to us that in the past, attempts to explain the lesions produced by infection upon kidneys previously damaged has been a potent source of error and that an understanding of the lesions found under these conditions is most likely to come through a study of the lesions produced in previously healthy kidneys. Therefore, in discussing the subject we have divided the field of renal infections into two groups: Group 1, including only those kidneys which were previously normal as far as the clinical evidence will permit of a decision, and Group 2, those in which infection was grafted upon some other lesion of the kidney, such as stone, tumor or dilatation due to obstruction.

Bacteria Circulate in the Blood and Are Excreted by the Kidney Without Producing Gross Lesions. Many years ago various observers, including Hoffman, Röhrig, Maas, Wiener, Rutimeyer and Cohnheim, showed that insoluble substances such as cinnabar and fat could be made to pass through the healthy kidney. Particles of these substances were found in the capsule of the glomerulus, in the tubules and in the urine. In 1896 Biedl and Kraus showed that the staphylococcus aureus, the bacillus coli and the anthrax bacillus passed through the healthy kidney. The same fact was demonstrated for the typhoid bacillus by Lumiere and Abrami, by Rosving for the bacillus coli, by Cuturi for the same organism, and by Patrick for various organisms in the course of typhoid fever. Meyer, Walschmann, Heyer, Kramer, Buday, Wyssokowitsch, Rolly, Brown and Cunningham have shown that in the course of tuberculous lesions elsewhere in the body, tubercle bacilli

appear in the urine at various times and in varying quantities without any evidence of damage to the kidney. Honeij has made a similar observation for the bacillus of leprosy. In this connection should be mentioned an interesting series of observations noted by Swart and Craig, that following the administration of salvarsan to patients with leprosy or patients with tuberculosis the bacilli appear in the urine in large numbers and the course of the disease is often unfavorably affected. On the other hand, Wyssokowitsch, in 1886, experimenting with a variety of pathogenic bacteria, including the pneumococcus, the typhoid bacillus, anthrax bacillus and the staphylococcus aureus, found them appearing in the urine with evidence of the production of kidney lesions. Similar conclusions were drawn by Cocordi in 1888, Pernice and Scagliosi in 1892, Sherrington in 1893, Cotton in 1895, and Jahn in 1910. This array of apparently conflicting testimony has brought certain eminent observers to the conclusion that in the cases where no lesion was discovered it was because a slight lesion had been overlooked. This we believe to be an entirely unwarranted conclusion. In view of the fact that insoluble substances have been shown to pass the kidneys without damage; in view of the fact that many competent observers have passed bacteria through the kidneys repeatedly and then examined these kidneys after sacrifice of the animal; and in view of the fact that we are daily accepting the clinical evidence obtained by the study of patients in regard to the integrity of their kidneys, we cannot avoid the conclusion that bacteria pass the healthy kidney. That they do not do so always or under all conditions simply confirms the well-known fact that local conditions in the kidney and general conditions in the organism influence the occurrence or non-occurrence of infections. While we are prepared to admit the accuracy of all the observations above quoted, they seem to us to prove conclusively that organisms circulate in the blood and pass through the kidney, in many cases without

producing any lesion and in many other cases with the production of various lesions.

Bacteria Circulate in the Blood and Are Excreted Through the Kidneys with Lesions Mild or Severe. In 1915 Kowitz, studying a group of children with infectious diarrhea, found the following sequence of events in five cases:

Blood cultures showed the bacillus coli. Promptly thereafter there appeared in the urine first albumin, then bacteria and finally pus. Exploration of the records of the medical services at the Massachusetts General Hospital has yielded us an interesting series of 8 cases of bacillemia and bacilluria which it may be noted occurred entirely in women. They entered the hospital with the diagnosis of fever of unknown origin.

Case 1. Woman of 35. Blood culture showed bacillus coli. Urine, profuse growth of the same organism. Physical examination negative except for elevation of pulse and temperature. Recovery.

Case 2. Woman of 29. Physical examination negative. Temperature 103°. Pulse 120. Widal negative. Blood culture, unknown bacillus. Urine, bacillus coli. Stool, persistently negative for typhoid bacilli. Recovery.

Case 3. Woman, 20. Entrance diagnosis, para-typhoid. Blood culture, bacillus coli. Urine culture, colon-like bacilli. Recovery.

Case 4. Woman, 23. Sister of Case 3. Entrance diagnosis, para-typhoid. Blood cultures lost. Urine culture, bacillus coli. Recovery.

Case 5. Woman, 30. Entrance diagnosis, question of typhoid. Blood cultures, profuse growth colon bacillus. Bladder urine, colon bacillus. Right ureter, colon bacillus. Left ureter, no growth. Persistent right pyelitis.

Case 6. Woman, 35. Entrance diagnosis, unknown fever. Temperature 102°. Pulse 95. Blood culture, colon bacillus. Urine culture, colon bacillus. Recovery.

Case 7. Woman, age —. Entrance diagnosis, acute infection. Temperature 100.5°. Pulse 98. Blood culture, motile bacillus. Bacillus para-typhoid? Urine, bacillus coli. Death one week. No autopsy.

Case 8. Woman, 62. Entrance diagnosis, convulsions. Temperature 102°. Pulse 110. Blood culture, colon-like bacilli. Urine culture, colon-like bacilli. Death, one week. Autopsy, calculus, pyonephrosis. Bilateral suppurative nephritis.

This group of cases is interesting from several points of view. Most of them were regarded as cases of probable typhoid and attention was particularly directed to this condition. Their blood, however, failed to show a Widal or to react to cultures of the para-typhoid bacillus and they were finally proved to be due to the other member of this group, the colon bacillus. We believe that these cases, simulating typhoid and due in fact to the colon bacillus, in other words, cases of colon bacillus bacillemia, are much more common than has been generally supposed. The records of any large hospital during recent years will show a considerable number of these cases in which clinical symptoms suggested typhoid, the diagnosis could not be confirmed, and they were finally discharged cured, often with a diagnosis of para-typhoid. A correct solution can be obtained only by careful study of the blood and urine with good technique, and particularly when they are seen at an early stage of the disease.

That the colon bacillus can be obtained from the blood in cases of acute pyelonephritis with considerable frequency has recently been shown by one of us (E. G. C.), who in a series of 32 cases obtained positive blood cultures in 40%, a ratio larger than that ordinarily obtainable in typhoid fever which is admitted to be a bacillemia. One case, occurring under our observation and carefully studied, throws considerable light upon the natural history of this process. "The patient was a man of 55 with benign enlargement of the prostate gland and residual urine. Cultures controlled by stained sedi-

ment showed the urine free from infection at entrance to the hospital. He was immediately placed upon constant drainage with an inlying catheter. Cultures from the bladder urine were taken the evening of the seventh day, up to which time he had complained of no symptoms whatever. These were sterile. At eleven o'clock of the eighth day he complained of a burning sensation in the urethra and two hours later had chill and sudden sharp rise in temperature. Blood cultures were taken 2½ hours from the beginning of symptoms of prostatic irritation and ½ hour after the appearance of the chill and rise of temperature. A pure growth of colon bacilli was obtained. Centrifuged urine obtained from the bladder at the time the blood culture was taken showed no bacteria in stained sediment. Cultures taken from the bladder urine the following morning showed an abundant growth of colon bacilli. Pus was present in very small amount. The renal functional test with phenolsulphonephthalein showed a drop in 24 hours of 20 points. The patient complained of right-sided costovertebral tenderness and headache and presented the usual symptom complex commonly called pyelitis, which we believe to be a pyelonephritis. He was allowed to remain on constant drainage for a week longer, during which time his phthalein output returned to within five points of its former level. Perineal prostatectomy was then done. The patient made an uneventful recovery until the 9th day, when he bled. The wound was packed and bleeding controlled. The temperature rose and the patient died. Necropsy showed anemia and streptococcus septicemia. The kidneys were pale with normal markings and little, if any, dilatation of the pelvis (Plate XVI, Fig. A). They were passed by the pathologist as "normal kidneys." This case clearly shows bacillemia, bacilluria, pyelitis and pyelonephritis. The evidence of pyelonephritis is based chiefly upon the sudden great drop in kidney function, which we think may be taken as evidence of acute cloudy swelling of the kidney, probably involving chiefly the tubular

portion. That this process is short-lived and goes on rapidly to practically complete recovery is suggested by the return of kidney function and conclusively proved by the appearance of the kidney postmortem.

Finally in support of the above-mentioned proposition we submit the results of the inoculation of a rabbit with the paratyphoid bacillus alpha. It should be remembered that the paratyphoid bacillus has for rabbits a pathogenicity quite similar to that shown by the colon bacillus in man. The cultures used in this experiment were three-year-old cultures. At the beginning of the experiment the bladder urine was shown to be sterile. An emulsion of the organisms, about 3 c.c. in amount, was introduced into the ear vein on three separate occasions during a period of five weeks. Following each injection the organisms appeared in the urine promptly and in enormous numbers. Five days following the last injection the animal was sacrificed. Sections of the kidneys carefully studied showed practically no lesions and were certainly within normal limits for laboratory animals (PLATE XVI, FIG. B.).

Ascending Infection by Way of the Urinary Passages. The theory that infections reach the kidney by direct extension from the lower urinary passages has acquired the dignity associated with old age and has been a widely held and attractive theory because of its extreme anatomic simplicity. We believe that it can be shown that its simplicity is apparent rather than real, that most of the cases in which it has been supposed to occur were based upon a complete misconception of the facts and that this method must in reality be regarded as exceptional. It has been customary to assume that in this method of renal infection the bacteria reached the kidney by one of three ways.

(1) By continuity from a bladder infection by direct extension of the process within the lumen of the ureter.

(2) By the transportation of the bacteria in a column of urine which is supposed to exist within the ureter. By this

PLATE XVI—Presented by Drs. Hugh Cabot and E. G. Crabtree

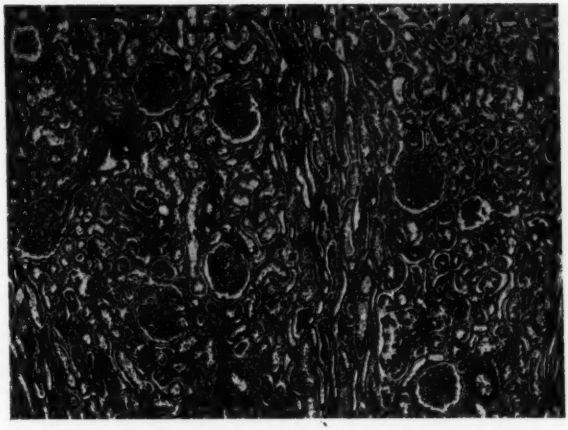
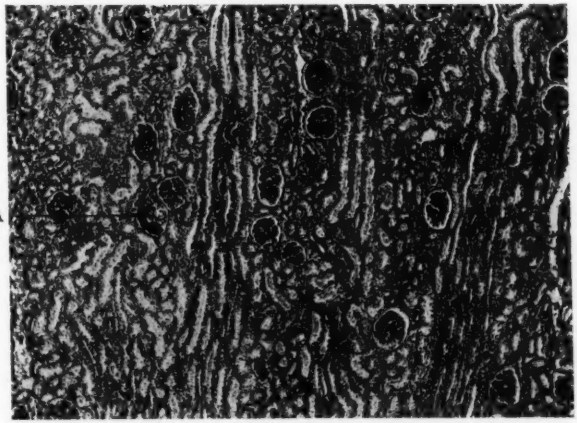


Fig. A. Typical microscopic field from kidney of patient known to have had colon pyelonephritis of hematogenous origin attended by marked fall in phthalein output and subsequent return to normal function. The kidney is essentially normal. (Photo by L. S. Brown x 45.)



A

Fig. B. Typical field from rabbit kidney through which Paratyphoid bacillus Alpha had been passed in large numbers on three occasions. Save for one changed glomerulus at (A) the kidney is normal. (Photo by L. S. Brown x 45.)

conception the bacteria float upward, apparently impelled also by their own motive power in contemptuous disregard of the descending stream of urine and ureteral peristalsis.

(3) By reverse peristalsis within the ureter. This of course presupposes obstruction of the ureter, since as far as we know there is no warrant for the assumption of reverse peristalsis in the absence of obstruction. That reverse peristalsis occurs in the presence of obstruction we believe to be a demonstrated fact, the best evidence of which in our personal experience has been the movement of ureteral calculi from kidney to lower end of ureter and then back again, a journey which could hardly be expected to take place under any force other than reverse peristalsis.

The whole theory of ascending infection rests primarily upon the proposition that infection of the bladder takes place under a great variety of conditions unassociated either with trauma or with retention, for, unless a preexisting cystitis is assumed, the whole proposition falls to the ground as applied to a great majority of the cases.

More than a quarter of a century ago Rosving and Melchior showed that (a) experimentally cystitis could not be produced in animals without retention or trauma; (b) that with retention of urine experimentally produced there generally resulted no pyelitis; (c) that trauma to the bladder with or without retention produced pyelitis and pyelonephritis. In passing it should be noted that in these later cases sections of the bladder wall showed extensive hemorrhage with bacteria in the blood and lymph channels, an observation the importance of which will later appear.

Bauereisen, concerning himself wholly with the lesions produced by the tubercle bacillus, drew three conclusions: (1) A bladder with intact mucosa cannot be infected. (2) With the flow of urine unhindered, tubercle bacilli cannot reach the kidney through the ureter. (3) Obstruction of the urinary stream will as a rule result in urogenous ascending infection of the

kidney. This last conclusion implies a dilatation of the ureter and an incompetent uretero-vesical valve.

Draper and Braasch in a very thorough piece of work in which they attempted to produce ascending renal infections, wholly failed to do so except by maintaining an abnormal amount of pressure in the bladder over a long period of time.

It thus appears that the experimental work wholly fails to support the assumption of ascending infection by means of the urinary passages. When produced as by Rosving and Melchior, there is no warrant for the assumption that it ascended, since the blood and lymph channels were shown to contain bacteria, and it is far more probable that the bacteria reached the kidneys by one or both of these routes. It is notorious that bacteria in the bladder, whether introduced from above or from below, fail over a long period of time to produce lesions. There is a mass of clinical evidence showing that tubercle bacilli coming from an infected kidney will pass for years through the bladder without producing a lesion. Of late years when the cystoscope and ureter catheter have made accurate diagnosis of conditions in the upper urinary tract possible, a multitude of observations have been recorded of colon bacillus pyelitis and pyelonephritis from which the colon bacillus passed to and through the bladder for years without producing a lesion.

A recent communication by Hess in which he described the results of investigations of the bacteriology of bladders immediately following cystoscopy, throws considerable light upon this question. He showed that in the first days following instrumentation bacteria of various kinds could be found in the bladder with regularity, that they produced neither the symptoms nor the signs of cystitis and that in a few days they disappeared. We have become wholly accustomed to regarding the cystoscopic examination of the bladder under normal conditions as a harmless procedure. If these observations of Hess be confirmed it shows that the harmlessness consists not

in the aseptic character of our procedure but in the vitality of the vesical mucous membrane and its ability to shake off the milder degrees of infection.

We do not intend to convey the impression that we believe that ascending infection from the lower to the upper urinary tract must be wholly discarded, for there are two conditions under which it is theoretically possible and practically probable. The first of these is ureteral obstruction, which may theoretically be of three types: that due to stone, that due to inflammatory stricture, and that produced by the abnormal constriction of the lower end of the ureter by hypertrophy of the bladder such as is seen in diverticulum, in tuberculosis and in obstructive conditions at or below the neck of the bladder. In hollow viscera elsewhere in the body obstruction is followed by reverse peristalsis with singular regularity and it is but reasonable to assume that the ureter, a hollow muscular organ, behaves in a similar fashion. Further warrant is given to this belief by the observation in regard to stone in the ureter above referred to. Now under conditions of reverse peristalsis, bladder infection with extension by direct continuity to the lowest portion of the ureter would give rise to conditions highly favorable to renal infection if assisted by reverse peristalsis. The other condition clearly opening the way to ascending infection is incompetence of the ureterovesical sphincter such as undoubtedly exists in a certain number of cases of obstruction at or below the vesical outlet. In these cases the dilatation has become so extreme that the renal pelvis is for all practical purposes in direct open communication with the bladder cavity and any condition existing in the latter will promptly be communicated to the former by the simple method of back-wash. Under these circumstances if the kidney is not already infected it will promptly become so.

The pyelitis, so called, of pregnancy, and the equally improperly termed pyelitis of childhood, have been the great

strongholds of the ascending infectionists. Their theory has been based chiefly on anatomical fact unsupported by clinical or experimental evidence. The short urethra and the comparative ease with which the region of the urinary meatus might be contaminated with the colon bacillus, together with the fact that in the adult female vesical irritability is often the first thing to attract attention, have been the two important premises. It has not been shown that the cystitis antedates the pyelitis, for the good and sufficient reason that such is rarely the case. Furthermore, should it be shown that the cystitis was primary there is no basis either in man or animals for the assumption that with neither retention nor trauma ascension could occur. The fact that this disease occurs with far greater frequency in the female, whether child or adult, is important but its significance has been wholly misunderstood. It is interesting to note that in the eight cases reported by us on pp. 167, 168 of proved bacillemia and bacilluria, all were women. In the adult female, there can, we think, be no doubt that the conditions normally existing in the large intestine are more favorable to the occurrence of bacillemia than in the male. There is as yet no adequate explanation of the greater frequency of these infections in the female child but we think that existing evidence points to the view that this explanation will be found not in the anatomical peculiarities of the female urethra but in the anatomical peculiarities of the female intestine.

Ascending Infection by the Lymphatics. For many years occasional observers have called attention to the possibility that bacteria might reach the kidney by way of the lymphatics. It has perhaps been most extensively discussed in connection with renal tuberculosis but of late years the discussion has been extended to include other organisms and a variety of publications showing careful anatomical study have tended to support the theoretical contentions.

Mascagni showed that the lymphatics of the upper ureter

PLATE XVII—Presented by Drs. Hugh Cabot and E. G. Crabtree

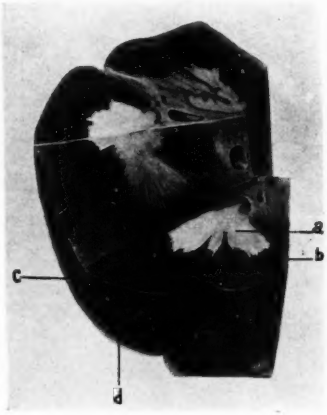


Fig. 1. Nephritis Papillaris Mycotica (Orth). A bilateral mixed colon bacillus and Streptococcus pyogenes infection of hematogenous origin. (a) Necrotic, anæmic papillæ. (b) Purplish zone surrounding necrotic papillæ. (c) Striations of cortex. (d) Mottling of cortex.

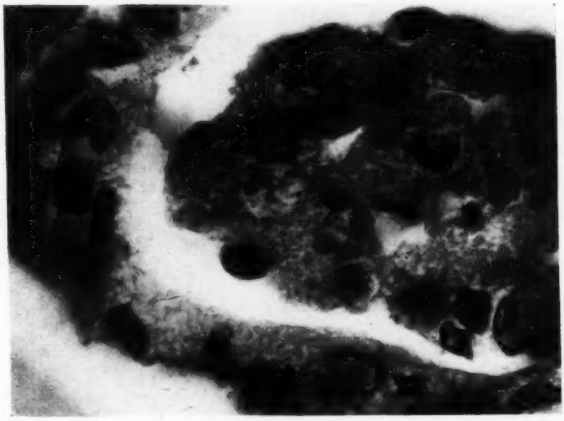


Fig. 2. Proximal convoluted tubule of the cortex filled with desquamated epithelium and containing bacteria.

drained into the lymphatic system in the region of the kidney pelvis and that organisms might reach the kidney along these channels. He also showed that the lymphatics of the lower ureter drained into the lymph nodes of the anatomical pelvis.

Sakata confirmed the above observations and further showed that the system of lymphatics of the upper ureter and the system of lymphatics of the lower ureter and bladder were connected by an intermediate chain of lymphatics embracing the central portion of the ureter. It is easy, however, to exaggerate the importance of this observation, since Sakata's work shows that this chain is not continuous, but is, on the contrary, highly interrupted. Organisms in order to extend from bladder to kidney by this route would have to pass through several systems of lymph nodes, a contingency which importantly decreases the probability of such an occurrence.

Sugimura studied a series of 21 cases and showed that in the presence of acute cystitis the lower third of the ureter was constantly involved, apparently through the medium of the lymphatics. He drew this conclusion because there was very slight involvement of the mucous membrane of the lower ureter, while the lymph channels of the muscularis and adventitia were extensively involved.

Francke has shown a lymphatic communication between the right kidney capsule and the adjacent ascending colon.

Kumata has demonstrated a system of superficial and deep lymphatics in the fatty capsule of the kidney. This system apparently drains away from the kidney communicating with the subdiaphragmatic lymphatics.

A recent paper by Eisendrath states his belief that he has demonstrated that bacteria ascend by the lymphatics from the bladder to the kidney and produce renal infection. After a careful study of this paper we regret that we are entirely unable to follow him to his conclusion. The method by which the lesions were produced is nowhere stated. The lesions are not

strikingly different from those which are found in blood-borne infections and finally the evidence which he submits of the lesions of the kidney is so meager and differs in such important particulars from the infectious lesions ordinarily found in the kidney that we must question their similarity.

Upon the framework of the above-mentioned anatomical observations several writers have attempted to erect a theory of lymphogenous infection of the kidney. Though the framework is valid in its individual members, the complete structure seems to us frail and insecure. It is generally believed, and upon sufficient evidence, that the lymphatic currents throughout the body follow the flow of blood in the blood vessels. Unless we are prepared to disregard this doctrine it will be difficult to trace lymphatic processes over areas which are totally lacking in continuous vascular channels. Now there are no blood vessels running an uninterrupted course from the bladder to the kidney. The blood supply of the ureter is distinctively segmental and the only vessels which run in this general direction are the spermatic vessels in the male and the ovarian vessels in the female. These run in different sheaths and would be with difficulty accessible to organisms passing outward from the bladder. Furthermore, assuming the probable fact that organisms reach the lymphatics about the bladder and the lower segment of the ureter, the probability of their reaching the blood stream rather than continuing in devious lymphatic channels seems to us overwhelming. That organisms pass from the bladder into the perivesical lymphatics, reach the blood stream and ultimately the kidney, we not only believe but are prepared to show (see p. 168) and this possibility must always be reckoned with. Reasoning from lesions produced by lymphatic infections elsewhere in the body, progress by this method is comparatively slow and on account of the interrupting lymph nodes is more likely to produce highly localized lesions than lesions spreading rapidly over long distances and flooding a distant area with or-

PLATE XVIII—Presented by Drs. Hugh Cabot and E. G. Crabtree

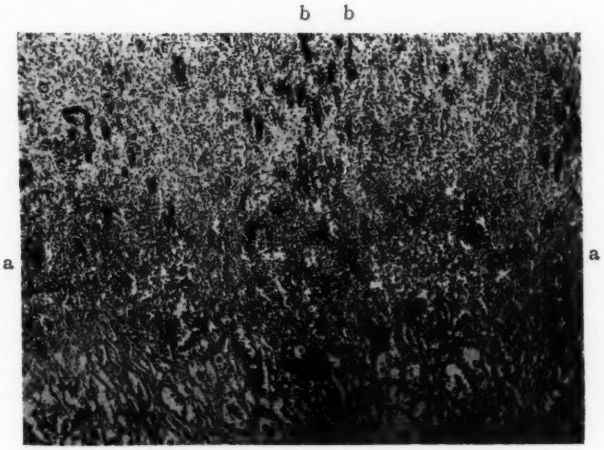


Fig. 3. Microphotograph of area of complete transverse lesion (a—a) at base of a pyramid. Below is shown necrotic pyramid. (b—b) Congested blood vessels.

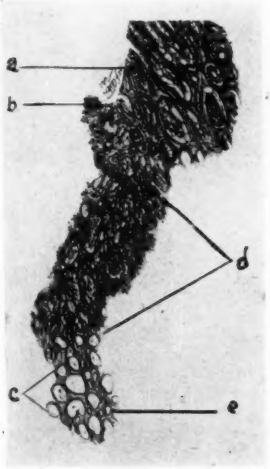


Fig. 4. Drawing through area of kidney including cortex, zone of suppuration and portion of necrotic papilla. (a) Fairly normal cortical tubules; (b) congested vein; (c) anæmic necrotic area of pyramid (a) Fig. 1; (d) area of transverse suppurative lesion (purplish area of Fig. 1 marked (b)); (e) empty blood vessels of anæmic papilla.

ganisms, which is the problem with which we are here concerned.

Finally, the evidence of the lesions actually produced in urinary tuberculosis is enlightening. It is generally recognized that the involvement of the ureter is earliest and most marked at its two extremities and it is not uncommon to find a central portion of the ureter wholly or comparatively free from tuberculous disease. Those who have regarded the work of Francke concerning the lymphatic communication between the ascending colon and the right kidney as conclusive, seem to us to be reasoning upon highly insecure premises. Arbeiter has shown that when organisms leave the intestine by the lymphatics they rapidly appear in the blood and this tendency is amply confirmed by a large series of observations which concern themselves not only with the migration of bacteria of the intestine into the lymphatics but with the ways in which foreign proteids leave the intestine under abnormal conditions.

Thiele and Embleton have shown that after peritoneal infection the organisms rapidly reach the blood stream and are excreted by the normal kidney. If, however, the thoracic duct be opened so that bacteria can escape no such excretion occurs.

If for a moment we disregard the large probability that bacteria leaving the intestines by the lymphatics will reach the blood stream rather than the kidney, we must yet believe that a lesion of the kidney thus produced would in all probability be a localized lesion rather than a widespread diffuse lesion such as is notoriously produced by bacteria of intestinal origin.

Why Assume that Cocci Generally Reach the Kidney by the Hematogenous Route, While Assuming that Colon Bacilli Generally Reach the Kidney by Ascension from the Bladder? It has been long assumed, and following the work of Brewer has been almost universally admitted, that the staphylococcus in-

fections of the kidney are of hematogenous origin. These infections have been shown to be associated with furunculosis, carbuncle and various septic foci elsewhere in the body. The identity of the organisms in both places and the impossibility of sustaining any assumption of transference other than the blood has led to these lesions being regarded not only as hematogenous lesions but the proposition has even been reversed and the hematogenous lesion has become almost synonymous with coccus infections. On the other hand, the infection of the kidney with the colon bacillus, of which the purest types are the pyelonephritis of infancy and pregnancy, has been regarded as ascending chiefly because of the delightful simplicity of the assumption. If, however, one inquires as to the evidence of the hematogenous origin of both these types of infection one is at once struck by the fact that the hematogenous origin of colon bacillus infections has been demonstrated beyond the shadow of a doubt, the organisms having been repeatedly found in the blood and subsequently in the urine, while as far as we are aware there are but few cases on record in which the cocci concerned in the so-called hematogenous coccus infection of the kidney has been captured during his journey through the blood. While this should not be taken as in any way tending to invalidate the hematogenous origin of the coccus lesion, it seems to us to at once put upon the defensive those who would assume that colon bacillus infections of the kidney are produced by any method other than the hematogenous one. At least as far as concerns the pyelonephritis of the group above referred to we shall later submit evidence which seems to us to show that they can be produced only by organisms reaching the kidney through the blood stream and that the theory of ascension is wholly mythical.

Possible Sources of Confusion in Previous Studies of Renal Infection. That the literature of renal infections is both confusing and confused no one who has attempted to digest it is

likely to deny. There appear to us to be two chief sources of this confusion, first a considerable lack of uniformity in the use of terms which at times amounts to a use so loose as to be positively misleading, and, second, an attempt to study complicated and mixed lesions which are likely to almost defy analysis.

1. At the outset, therefore, of the discussion of our own findings we desire to state clearly our understanding of the terms embolic, metastatic, hematogenous, excretory, lymphogenous and ascending as applied to renal infection.

A suppurative lesion of the kidney we regard as *embolic* when a definite embolus shown to contain microorganisms has been demonstrated in a blood vessel at the apex of the lesion. This term has, we think, frequently been used to cover numerous lesions which were in no proper sense embolic in character.

A *metastastic* lesion of the kidney we understand to mean a suppurative lesion produced by an organism of the same character as one concerned in a demonstrable suppurative lesion elsewhere in the body.

The term *hematogenous* we hold to mean simply that the organisms reach the kidney by the blood.

An *excretory* lesion is one produced during the process of excretion of organisms by the kidney. It will thus be seen that the terms hematogenous and excretory cover very nearly the same ground. Clearly no excretory lesions can occur unless the organisms have arrived by the blood and we expect to show that organisms which arrive by the blood and do not produce emboli very generally do produce excretory lesions.

Lymphogenous covers all the suppurative processes demonstrated to be produced in the kidney by bacteria which have arrived solely via the lymphatics.

And finally, *ascending infection,* a much abused term, we hold to mean the direct ascension of organisms from bladder to kidney by the lumen of the ureter. This process may in-

clude either a direct extension along a mucous membrane or a direct transference from bladder to kidney with the urine as a vehicle.

2. We believe that a comprehension of renal infections is very much simplified if they be separated into two main groups, Group I including all those infections of the kidney which occur in an organ previously sound, and Group II those infections which occur in a kidney previously unsound, such as those damaged by stone, tumor, obstruction, or chronic nephritis.

A classification of the infections occurring in Group I has seemed to us, after a not inconsiderable experience, to be comparatively simple. We have as a rule been able to come to a satisfactory conclusion as to the cause and nature of the process, and to arrange the lesions in an orderly and comprehensible fashion. On the other hand, there have been many cases falling under the classification of Group II in which the complication of lesions of various dates and of essentially different pathological characteristics was such as to largely defy satisfactory explanation. For example, a kidney long the resting-place of a stone may show a variety of practically healed lesions, the original nature of which must be permanently in doubt. Coupled with these may be two, or even three, more recent infections overlapping each other in position and perhaps in point of time, and giving a picture so confusing as to be quite beyond us. It may well be that a more extensive study of the cases in Group I will enable one to make a fairly accurate guess as to the probable cause of the various lesions of such a kidney as above described.

A Study of the Lesions Actually Found in Renal Infections.[1]

[1] In all the following case reports gross descriptions and microscopical examinations of sections are copied from the autopsy protocols of Dr. J. H. Wright and Dr. Oscar Richardson. Where specimens from operations are used the above descriptions are copied from the reports dictated by Dr. Whitney and Dr. Hartwell of the laboratory of the surgical pathology department. Where more detailed observations than is possible in routine work were required they are given under the heading of "sections stained for bacteria" which we have appended.

For this study we have utilized a group of 118 cases classified as suppurative nephritis. These include both cases studied at autopsy and specimens obtained at operation, so that we have not been confined to one particular type of material. Of these 118 cases we have been obliged to discard 58 because they either represented material obtained at autopsies done several years ago from which the paraffin blocks had been lost, or the lesions were too chronic and too complicated to lend themselves satisfactorily to classification; or finally those in which we were unable to demonstrate bacteria. There thus remains a group of 60 cases divided as follows:

23 were caused by and were demonstrated to contain staphylococci alone.
4 streptococci alone.
3 staphylococci and streptococci.
25 were demonstrated to contain mixed cocci and bacilli.
19 of these showed staphylococci and bacilli.
4 showed streptococci and bacilli.
2 showed staphylococci, streptococci and bacilli.
5 showed bacilli only.
In 3 the bacillus coli, and in
2 the bacillus coli and another bacillus clearly a pyogenic organism.

1. *Evidence of the Production of Lesions During the Process of Excretion of Bacteria.* The case for this proposition was clearly stated by J. W. Thomson-Walker in his work on "Surgical Diseases and Injuries of the Genito-Urinary Organs," p. 120.

"It is now recognized that bacteria are constantly entering the lymphatics from the intestine and other sources in healthy individuals. The bacteria may be destroyed at the point of entry or at the lymphatic glands, or they may pass through the lymphatic system into the blood stream, in which they circulate. The endothelium and cells of the liver destroy bacteria which are introduced by way of the portal system, and

bacteria are excreted in the bile. Similarly a function of the renal parenchyma, especially of the convoluted tubules, is to remove the bacteria present in the systemic circulation.

"It has been proved that the virulence of these bacteria is not reduced in their passage through the body. The excretion of bacteria in this way does not give rise to any symptoms which show that the kidneys are damaged. It is stated, however, as the result of experiments on animals, that the secreting membrane is injured by the passage of the bacteria. The damage is probably slight, and is repaired partly or completely by the regenerative powers of the kidney. In some cases long-continued excretion of bacteria or their toxins may be the cause of patches of interstitial nephritis in the kidney.

"It is held that the excretion of bacteria does not cause pyelonephritis unless some additional factor is present. Predisposing causes of pyelonephritis are traumatism, excessive functional activity, the elimination of toxic bodies such as cantharides, previous disease of the kidney such as urinary obstruction, calculus, new growth. It is exceptional, however, to find any of these factors present, and it is more likely that chronic toxemia from constipation, an excessive dose and an exceptionally virulent strain of bacteria, are the decisive factors."

It was also clearly stated by Orth in 1893.

"The question of the method by which bacteria reach the tubules in the pyramidal zones can, in my opinion, only be explained by assuming their passage from the blood into the capsule of the glomerulus and their being carried along into the collecting tubules with the urine where they group together, become arrested and continue to grow."

We append three cases which seem to us to clearly support the doctrines thus laid down.

Case 1. Autopsy No. 3539. West Medical, 205300. Female, aged 56. Nov. 15, 1915.

Diagnosis. Diabetes mellitus. P. H. Negative save for

present symptoms which appeared four years ago. P. I. Only symptoms are those of diabetes. Physical examination negative as regards urinary tract. Patient was made and kept sugar free with great difficulty and lost weight and strength under the treatment.

Urine examination at entrance showed sugar 7.8%, diacetic acid and acetone; no albumin, occasional pus cell.

Urine examination, Jan. 14, 1916, showed traces of albumin but scanty sediment containing only a few cells; no sugar.

Temperature remained normal to subnormal from entrance to Jan. 9th, when it suddenly became a swinging septic temperature ranging from normal to 102°. Blood cultures were negative, white count never above 9000. Renal function (phthalein) fell to 15% for two hours. Death attributed clinically to acidosis and terminal infection.

Clinical Diagnosis. Diabetes mellitus. Terminal infection.

Autopsy. 9¾ hours post mortem.

Anatomical Diagnosis. (Diabetes mellitus) Lobular pneumonia. Acute pleuritis with effusion. Arteriosclerosis. Fibromata of uterus. Chronic peritonitis and chronic salpingitis. Chronic interstitial hepatitis. Chronic interstitial pneumonitis. Nephritis papillaris mycotica. Colon bacillus and streptococcus septicemia.

Kidneys. (Plate XVII, Fig. 1.) Combined weight 500 grams. Organs are enlarged. Capsules strip easily leaving a fairly smooth dark brownish surface generally mottled with small brownish areas dotted over which are numerous grayish points. The surface of one kidney shows in two places small, pale yellowish white areas 3 to 5 mm. across. On section the tissue is of increased consistence and shows in the regions of nearly all the pyramids of one kidney and in many pyramids of the other numerous yellowish, necrotic, homogenous, rather firm masses of various size and shape, some of them measuring only a few millimeters across, and others occupying the entire pyramid. As a rule the masses reach to within 3 or 4

mm. of the cortex although in two places there are slender prolongations of the masses through the cortex to the surface where they appear as the two pale yellowish areas previously mentioned. Margins of these masses in the pyramidal region are slightly serrated and the mass extends to the tip of the pyramid. The tissue bordering the mass is purplish black and homogeneous. From this blackish area dark lines extend in places up through the cortex and are in relation with the blackish areas mentioned as pressing on the surface. The cut surface of the cortex shows generally a pale brownish to dark brownish background mottled in places with the blackish areas mentioned. The kidney markings are visible. Pelves and ureters negative. Bladder negative.

Bacteriological Report. Culture from heart blood growth of colon bacilli and streptococci. Spleen, colon bacilli. Kidney tissue, colon bacilli. *Microscopic* sections show on the surface of the cortex, in the regions previously mentioned as mottling, rare infiltration of the interstitial tissue with polynuclear leucocytes and lymphocytes. Extending from these areas in the interstitial tissue between the tubules are lines of similar infiltration extending down to meet the areas of necrosis. The glomeruli are normal, the tubular epithelium of the tubules of the cortical region is for the most part unchanged. In some of the convoluted tubules are masses of desquamating epithelial cells and leucocytes (PLATE XVII, FIG. 2). In many cases these tubules and their contents appear to form the centers of abscesses surrounded by extensive polynuclear infiltration of the interstitial tissues. The blood vessels throughout the cortex are much engorged. In the region of the distal convoluted tubules and the bases of the pyramids there is an extensive suppurative process extending transversely across the base of the pyramid, in some instances completely separating it from the cortical tissue. This area corresponds with the previously mentioned purplish black area seen in gross section (FIG. 1). There is complete trans-

PLATE XIX—Presented by Drs. Hugh Cabot and E. G. Crabtree

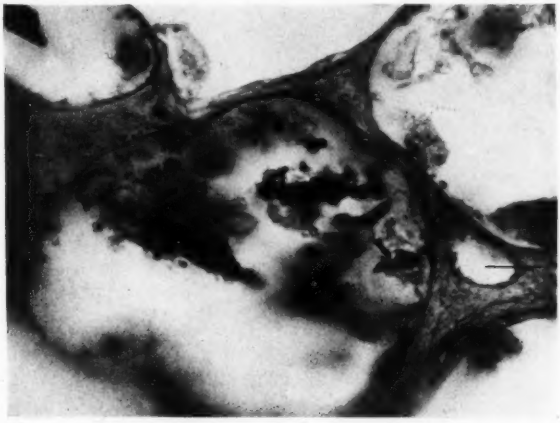


Fig. 5. Microphotograph of a necrotic anæmic papilla showing necrosis of interstitial tissue and epithelium of the tubules with fragmentation of nuclei and loss of cell outline. The lumen of one tubule is seen filled with large clumps of bacteria (almost entirely colon bacilli). Empty blood vessel seen at (a). Bacilli treated with 40% formalin to cause them to retain the Gram-stain for photographic purposes. Photo by L. S. Brown x 1,500.

Fig. 6. Microphotograph showing destruction of a tubule by bacteria contained within its lumen. Remnant of tubule seen to the left. Bacteria are chiefly streptococci. Photo by L. S. Brown x 1,500.

verse necrosis of all structures including blood vessels, tubules and interstitial tissue at the level of the bases of the pyramids (Figs. 3 and 4). The blood vessels are often found ruptured with liberation of blood corpuscles into the necrotic area and there is profuse infiltration of polynuclear leucocytes, fragments of renal epithelium, and red blood cells. The necrotic tips of the pyramids previously mentioned show a homogeneous smooth structure with necrosis as well as fragmentation of nuclei and loss of cell outline without any evidence of infiltration (Fig. 5). The blood vessels of the pyramids are empty. The lumens of the straight tubules are filled with masses of detritus. In some areas, in which the necrotic process is not so complete, the contents of the tubule is the center of abscess formation (Fig. 6). The cells of the tubule, containing the masses of detritus, and the interstitial tissue as well as the neighboring tubules show a narrow zone of necrosis outside of which is an extensive infiltration of polynuclear cells.

Sections stained for bacteria show very rarely a short chain of streptococci in the blood stream and capillary tufts of the glomeruli. The mass of cells found in the convoluted tubules of the cortex are shown to contain large numbers of bacilli and a few chains of streptococci (Fig. 2). In many places tubules which contain cell detritus show considerable numbers of bacilli within the epithelial cells. A few streptococci and bacilli are found in the infiltrated interstitial tissues. The necrotic area at the base of the pyramid already described shows an extensive bacterial invasion of bacilli and streptococci but with fragments of tubules loaded with bacteria apparently serving as the center of necrosis. Streptococci are much more numerous in this region than in any other portion of the kidney. The masses of detritus in the tubules of the pyramids are seen to consist almost entirely of large masses of bacilli (Plate XIX, Fig. 5). Very few streptococci are found in this region.

Note. The explanation of the pathological picture presented

in this kidney seems to point towards an early infection with colon bacilli in which the bacilli have been excreted through normal glomeruli. Some have been arrested high in the convoluted tubules, many more in the distal convoluted tubules, while large numbers have reached the straight tubules and some even to the pelvis of the kidney. A subsequent infection with streptococci in which most of the streptococci have also passed the glomerulus seems to have taken place. The streptococci have been arrested in the already damaged distal convoluted tubules and have produced along with the colon bacilli an extensive suppurative process at the bases of the pyramids with resulting complete transverse lesion of all structures at that level. Inasmuch as the blood supply of the pyramid is from above downwards from the point of vessel division at the base of the pyramid, the transverse lesions with rupture of blood vessels at this point has resulted in anemia and subsequent necrosis of the pyramid. There are but two areas in this kidney in which a question of embolism needs to be considered, namely, the two areas of pyramidal necrosis of the cortex previously described.

Case 2. *Autopsy* No. 3427. East Medical 967-89. Female, 21, January 13, 1915.

Admission Diagnosis. Pneumonia, arthritis. *Present Illness.* No previous urinary difficulties. Normal delivery four days ago, following which the patient began to have abdominal pain with chills and fever.

Urine. Acid, very slight trace of albumin, many granular casts, red blood cells and leucocytes. *Blood culture,* no growth. Culture from cervix showed staphylococci and bacilli, one a fusiform bacillus. Smear from cervix showed many staphylococci and streptococci. Patient died seventeenth day.

Clinical Diagnosis. Puerperal septicemia, bronchopneumonia, endocarditis, septic arthritis.

Autopsy. 9¾ hours post mortem. *Anatomical Diagnosis:*

PLATE XX—Presented by Drs. Hugh Cabot and E. G. Crabtree

Fig. 7. Lozenge-shaped abscesses in the collecting tubules of a pyramid. The dark masses are streptococci and colon bacilli. The pale area just outside the clumps of bacteria is necrotic epithelium of the tubule. The whole is surrounded by a border of pus cell infiltration. Photo by L. S. Brown x 40.

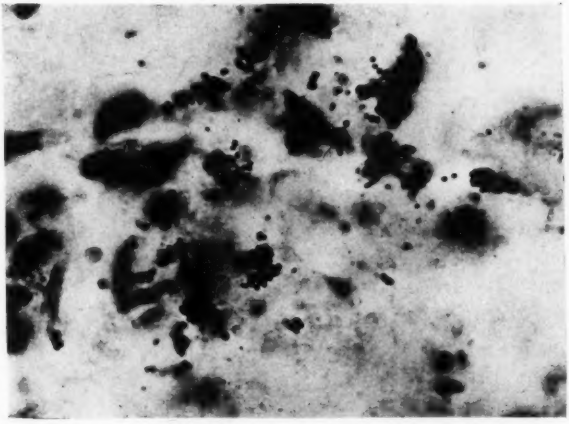


Fig. 8. Streptococci and rare bacilli in center of lozenge-shaped abscess shown in Fig. 7. Note remnants of tubular epithelium and absence of pus cells in this area which is the remnant of a tubule. Photo by L. S. Brown x 1,500.

Puerperal septicemia. Diphtheritic endometritis. Rupture of vagina with necrosis of perivaginal tissue. Septic arthritis. Diphtheritic colitis. Soft spleen with infarcts. Pyelitis. Nephritis papillaris mycotica. Streptococcus septicemia.

Kidneys. Kidneys much enlarged. Combined weight 558 grams. Capsules strip leaving a pale brownish red smooth surface. On section the tissue is swollen but markings are retained. The cortex is not narrowed. The cortices are pale brown red with a slight purplish cast. The pyramids are dark brown and in the region of the apices many of them show pale yellowish opaque smooth discrete and confluent streaks. The glomeruli show no definite prominence. The pelves show injection of the blood vessels with minute reddish spots. The ureters and bladder are normal.

Microscopic Examination. Throughout the whole tissue there is marked edema. The cortical portions of the kidney show normal glomeruli with some congestion of the blood vessels and the great majority of the cortical tubules free from pus but the epithelium shows cloudy swelling. In one portion of the kidney there is an area of extensive infiltration and necrosis of all renal tissue extending transversely across a portion of one of the pyramids. In this area the tubular epithelium is necrotic, the blood vessels are ruptured and the portion of the pyramid beyond is anemic. Above the area of necrosis the blood vessels are congested. In the remaining pyramids there are fine streaks of polymorphonuclear infiltration extending from the bases of the pyramids towards the apex (Fig. 7). In the least extensive of these processes the lumen of the tubule is seen to contain clumps of bacteria surrounding which is a lozenge-shaped area of necrosis including the epithelium of the tubule and the interstitial tissue on each side, sometimes extending far enough to include the adjacent tubule on each side. Beyond this area is a border of pus cell infiltration. Occasionally throughout the cortical regions there are a few tubules containing pus cells.

Bacteriological Report. Cultures from the spleen show profuse growth of streptococci and questionable bacilli; cultures from the heart blood show profuse growth of streptococcus.

Sections Stained for Bacteria show a few streptococci and bacilli without attending suppurative processes in the glomeruli and tubules of the cortex. In some instances considerable numbers of these organisms are found in the tubules containing the pus cells previously described (Fig. 8). In the area of transverse lesion of a portion of a pyramid previously described the tubules at the level of the necrotic area are found in many cases almost completely destroyed, yet the portions of the tubular epithelium remaining present the picture of necrosis due to the presence of a large number of streptococci and a few bacilli within the lumen. Between these remnants of tubules is extensive infiltration with polymorphonuclear leucocytes, fragments of renal epithelium and some free blood. The bacteria found in the whole area of necrosis just described are chiefly situated in the remnants of tubules with a few scattered bacteria among the blood and pus cells between the tubules. In the anemic area at the tip of the pyramid just described the blood vessels are entirely empty. There is no infiltration of the interstitial tissue. The tubules contain large plugs of streptococci and bacilli; the former greatly predominate. In the small lozenge-shaped areas in the region of the straight tubules previously described, the central area, that is the lumen of the tubule, is seen to consist of large numbers of streptococci and a few bacilli. Surrounding this group of bacteria is to be seen necrotic tubular epithelium surrounded by a zone of pus cells. Among the pus cells of the periphery bacteria are found with great difficulty. The pelvis of the kidney contains streptococci and bacilli.

Case 3. *Autopsy* No. 3575. West Surgical 207462. Male, 22, March 26, 1916.

Admission Diagnosis. Carbuncle of neck. *Present Illness.*

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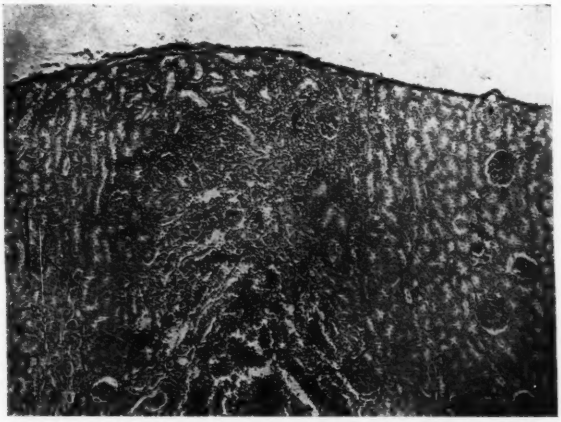

Fig. 9. Upper edge of small cortical abscess 2 mm. below the capsule. Infecting agent, pure staphylococcus albus. Note that remnants of tubules above the abscess contain no pus. There is extensive infiltration of the interstitial tissue extending from the abscess to the cortex. Neighboring tissue is normal. Photo by L. S. Brown x 40.

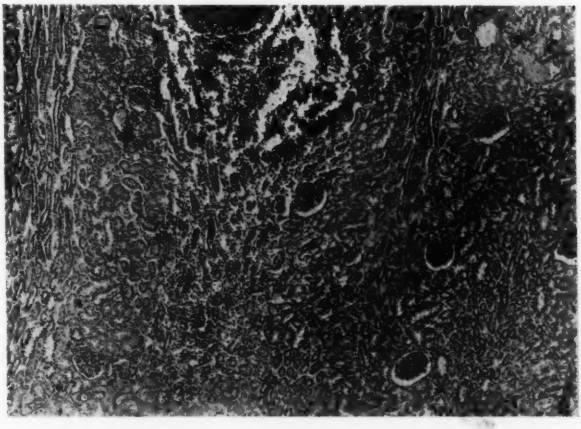

Fig. 10. Lower edge of abscess shown in Fig. 9. Note line of tubules filled with pus extending down into the kidney. There is some pus cell infiltration of the interstitial tissue. Photo by L. S. Brown x 40.

No previous urinary symptoms. Carbuncle of neck one week's duration. *Operation.* Incision of carbuncle followed by secondary operation for cellulitis of neck. Patient died fifth day. Culture from carbuncle staphylococci. *Urine.* Acid, albumin, slightest possible trace, rare epithelial and pus cell.

Clinical Diagnosis. Septicemia.

Autopsy. 18¼ hours post mortem. *Anatomical Diagnosis:* Operation wound. Carbuncle of neck. Abscesses of lungs, myocardium, kidneys and rectus muscle. Small mural thrombus right ventricle. Acute pericarditis, peritonitis. Soft spleen. Staphylococcus septicemia.

Kidneys. Combined weight 396 grams. Capsules strip easily. Surfaces show at several points minute yellowish spots situated singly and in groups. On section these are seen to be the surfaces of small collections of pus. Usually they arise within the cortex but in many instances they extend down often within the central portion of a pyramid as far as the middle of the pyramid. Markings retained, cortex not narrowed. The pelves, ureters, bladder and urethra are negative.

Microscopic Examination. There is edema with some few areas of acute degeneration throughout the otherwise normal kidney tissue. Numerous sections show the presence of abscesses, mostly in the cortex (Figs. 9, 10 and 11), some in the pyramids and one or two at the tips of the pyramids. In none of these is there evidence of embolism. The majority of the abscesses of the cortex appear to take origin in glomeruli. The abscess is surrounded by a generous polynuclear infiltration. In most instances the abscess is situated a few millimeters below the surface (Fig. 9). In these instances the tubules leading down into the kidney substance are seen filled with polymorphonuclear leucocytes and surrounded by considerable polynuclear infiltration of the interstitial tissue (Fig. 10). These tubules often lead downwards to a second and even third abscess apparently of more recent origin than

the one near the surface (Fig. 11). These secondary abscesses show the tubules both above and below them to be filled with polymorphonuclear leucocytes to a considerable distance from the abscess. In one instance a third abscess was found located just beneath the mucosa of the pelvis in the tip of the pyramid and showing a fine line of interstitial pus cell infiltration connecting it with the overlying two abscesses (Fig. 12). A noteworthy observation found with constancy is that where an abscess is situated a few millimeters below the surface of the kidney, the tubules above, although they may be surrounded by pus cell infiltration, do not contain pus (Fig. 9), while those tubules below the abscess contain considerable pus (Fig. 10).

Bacteriological Report. Cultures from the heart blood, operation wound, abscess of the rectus muscle and fluid from the peritoneal cavity show profuse growth of staphylococcus albus. *Sections stained for bacteria* show only staphylococci. These are found in large masses within the abscesses, are almost universally found within the tubules containing pus, are occasionally found in apparently undamaged tubules immediately beneath abscesses, and are found in large plugs apparently arrested within the tubules at the tips of the pyramid. The pelvis contains a considerable number of staphylococci.

2. *The Lesions Produced by Pyogenic Organisms Differ in Essential Particulars and Are Distinguishable From Those Produced by Non-Pyogenic Organisms.* In much of the literature of renal infections one must inevitably infer that the authors believe that no definite distinction can be drawn between lesions produced by different types of bacteria. Thus Mallory in his "Principles of Pathological Histology," p. 573, says:

"The lesions produced by a number of organisms may closely resemble one another. On this account an etiological classification is ordinarily carried out with only a few organisms, such as the tubercle bacillus and treponema pal-

lidum." Following the same idea he says somewhat later, "Infectious agents which most commonly produce lesions of the kidney are the staphylococcus aureus, the streptococcus pyogenes, the bacillus coli and the tubercle bacillus. Other organisms which occur less commonly are micrococcus lanceolatus, the bacillus mucosus capsulatus, actinomyces, and triponema pallidum."

Thomson Walker has this to say upon the subject of the bacteriology of renal infections: "The bacillus coli communis is the most common cause of renal infection, occurring in 75 per cent of cases. The next most frequent are the staphylococcus (especially the aureus), the streptococcus, the proteus of Hauser, and the bacillus pyocyaneus." A little later, under the heading of Pyelitis of Pregnancy, he says, "The bacteriology is similar to that of other renal infections."

In contra-distinction to these views, we believe that the lesions produced by the cocci and pyogenic bacilli (the pyogenic group) differ essentially from the lesions produced by non-suppurative organisms, chiefly the colon-typhoid group.

3. *The Lesions Produced by the Pyogenic Group.* These lesions consist of perinephritic abscess, capsular abscess, capsulitis, cortical abscess, septic infarct and diffuse suppuration. In support of this proposition we submit Cases 4-28, inclusive.

Case 4. *Specimen No.* 15.3-39. West Surgical 937-273. Male, 45. February 26, 1915.

Admission Diagnosis. Stone in right kidney. *Present Illness.* No previous bladder symptoms. Three months ago sudden sharp non-radiating pain in right flank accompanied by nausea and vomiting, with temperature which has continued. He had had some hematuria. *Physical examination* shows much spasm and enlarged kidney on right.

Urine at admission, acid, very slight trace of albumin, many leucocytes, rare red blood corpuscle.

Cystoscopy, bladder normal, right kidney infected with

staphylococci, renal pelvis not abnormal, which excludes tumor and pyonephrosis. *Diagnosis.* Staphylococcus infection of right kidney, nephrectomy advised.

X-Ray. Right kidney enlarged; no evidence of stone.

Culture from urine showed staphylococcus pyogenes aureus.

Operation. Nephrectomy. Kidney found enlarged, covered by a thick fibrous capsule which was edematous. Capsule which was ½ cm. thick stripped off with difficulty and several small abscesses evacuated in the process. Kidney was large, whitish with red-yellow mottling. Pelvis not dilated; ureter normal. Uneventful recovery.

Pathological Report. A somewhat enlarged kidney with adherent perirenal fat. Sections show multiple abscesses scattered throughout the cortex and medulla. Intervening tissue opaque. Examination shows extensive infiltration with round cells with here and there abscess formation. Tubular epithelium is swollen. Multiple abscesses present.

Sections Stained for Bacteria show many staphylococci in clumps in the abscesses. A few bacteria are to be seen in the areas of infiltration above described. These areas show subacute infectious processes with obliteration of the tubules to such an extent that the bacteria outside abscesses cannot be located with accuracy. Cocci are present in the pelvis without any evidence of pyelitis.

Case 5. *Autopsy* No. 232. West Surgical 331-111. Male, 20. March 6, 1898.

Present Illness. Septic finger, two weeks' duration. *Operation.* Incision and drainage. *Temperature* at admission, 104-8°. Pus from hand showed staphylococcus pyogenes aureus and bacilli. Patient died fifth day with symptoms of pneumonia.

Clinical Diagnosis. Septic hand, metastatic pneumonia.

Autopsy. 5 hours post mortem. *Anatomical Diagnosis*: Gangrene of finger. Phlegmon of arm. Secondary abscess sterno-clavicular articulation and subpubic connective tissue.

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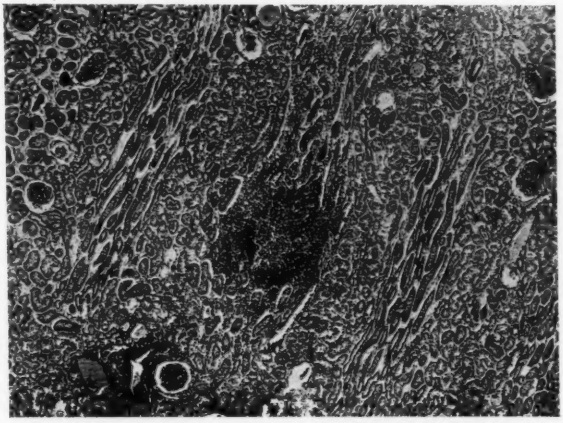

Fig. 11. Small abscess found immediately below abscess shown in Figs. 9 and 10 in a column of Bertini. Note line of tubules filled with pus cells and found to contain bacteria extending upwards to connect with similar tubules shown in Fig. 10. The abscess shown here is situated in the bend of the loops of Henle. Photo by L. S. Brown x 40.

Fig. 12. A third abscess underlying the two shown in Figs. 9, 10 and 11, situated in the straight tubules of the tip of the papilla. Elsewhere in the tubules of this pyramid tip are to be found small masses of staphylococci, some with attendant beginning abscess formation. Photo by L. S. Brown x 40.

Abscesses of lungs and kidneys. Acute hyperplasia of spleen.

Kidneys. Considerably enlarged. Capsules strip easily revealing numerous small abscesses in the substance of the kidney. On section similar abscesses are seen scattered irregularly through the cortex and less abundantly in the pyramids. Cortical tissues opaque and swollen.

Bacteriological Report. Cultures from abscesses of kidney and lung and heart blood show growths of staphylococcus pyogenes aureus.

Sections Stained for Bacteria. Numerous staphylococci in the abscesses, some few in the blood stream. The majority of glomeruli and tubules apparently undamaged. Many abscesses in the pyramids appear from the location of bacteria to take origin from lumens of tubules. Many epithelial cells are filled with phagocyted cocci. In one or two areas abscesses appear to take origin in the interstitial tissue in one of which an embolus can be demonstrated.

Case 6. *Autopsy* No. 2492. West Surgical 647-275. Male, 34. November 23, 1909.

Present Illness. Admitted with diagnosis of tumor of the bladder with cystitis. Temperature 101°.

Urine. Neutral reaction, albumin ¼%; sediment much blood. Patient, unable to void on account of hematuria, placed on constant drainage. Amount of urine extremely small. Patient died unoperated on the twentieth day.

Clinical Diagnosis. Tuberculosis of the prostate?, uremia.

Autopsy. 11½ hours post mortem. *Anatomical Diagnosis:* Squamous cell carcinoma of bladder with bone formation in the stroma. Suppurative nephritis of right kidney. Occlusion of ureters in bladder wall. Atrophy of right kidney with pelvic dilatation. Compensatory hypertrophy of left kidney. Dilatation of ureters.

Kidneys. Right kidney weighs 109 grams, left, 268 grams. Capsules strip easily. Markings of the left kidney are re-

tained; right kidney not clearly defined. Cortex of right kidney is narrowed, that of left is normal. The pelvis of the right kidney is dilated, leaving only a small amount of kidney tissue. Scattered throughout the kidney tissue are numerous small dark red hemorrhagic areas. The left kidney shows a slightly dilated pelvis. Both ureters are markedly dilated, the right filled with blood. Probe cannot be made to pass through the uretro-vesicle orifice on either side. The bladder wall is markedly thickened, especially on the right, where there is a large grayish-white mass extending beyond the median line and infiltrating the bladder wall.

Microscopic Examination. Right kidney shows much fibroid atrophy of the tubules and glomeruli and infiltration with lymphocytes. Here and there small abscesses are present. Left kidney shows edema. Here and there a small focus of atrophy with lymphocytic infiltration is seen.

Bacteriological Report. Cultures from the heart blood show no growth.

Sections Stained for Bacteria. The sections preserved from this autopsy show no true abscesses but only low grade kidney change. Large cocci found in the glomeruli of the tubules and scattered throughout the interstitial tissue may be post mortem invasion.

Case 7. *Autopsy* No. 2364. South Surgical CLXXIX-203. Female, 1 yr. 10 mos., May 7, 1909.

Present Illness. Comes in for tumor of the left kidney. For past two weeks has had hematuria followed by fever. *Temperature* at entrance, 102°.

Second day after admission to the hospital, while eating, child suddenly uttered a piercing shriek, turned cyanotic and died.

Clinical Diagnosis. Sarcoma of kidney, pulmonary embolism.

Autopsy. 4 hours post mortem. *Anatomical Diagnosis.* Adeno-sarcoma of the left kidney with metastasis in the ab-

dominal lymph nodes. Suppurative nephritis. Pulmonary embolism.

Kidneys. The left ureter when followed upwards opens into an irregular yellow mass which contains considerable broken down creamy white material. Just beyond the opening of the ureter there is a small strip of tissue showing markings with pyramids and glomeruli. In one place there is a streak of yellow running through what appears to be a pyramid. This kidney tissue is continuous with and passes over into a large tumor mass. The ureters and bladder are normal.

Microscopic Examination. Section shows the tumor to consist of adeno-sarcoma of the kidney. In one section in some of the renal tissue are follicles of lymphoid tissue. In the right kidney there are foci of suppurative nephritis.

Bacteriological Report. Culture from the heart blood shows no growth.

Sections Stained for Bacteria. In three places in the kidney small arteries are found plugged with a hyaline mass containing a few partly disintegrated cells and large numbers of staphylococci. In one instance there is evidence of some suppuration about the plug while in the other two there is no evidence of tissue change.

Case 8. *Autopsy* No. 623. South Surgical XLVIII-148. Male, aged 15, November 8, 1900.

Admission Diagnosis. Septic arm. *Present Illness.* Five months ago felon of finger now healed. Two days ago, without apparent cause, right elbow became swollen and painful. *Temperature* 102°.

Operation. Incision and drainage of elbow joint. Pus showed staphylococcus pyogenes aureus. Died ninth day.

Urine examination not recorded.

Diagnosis. Septicemia, osteomyelitis.

Autopsy. 19½ hours post mortem. *Anatomical Diagnosis:* Operation wound of right arm with osteomyelitis of the humerus. Multiple abscesses of the lungs. Sero-fibrinous

pericarditis. Abscesses of the myocardium. Abscesses of the prostate. Suppurative nephritis. Acute degeneration of the liver. Acute hyperplasia of spleen. Ecchymosis in the mucosa of the stomach. Tuberculosis of the left epididymis and testis. Staphylococcus septicemia.

Kidneys. At several points in each kidney just beneath the capsule are yellowish purulent foci the size of a pinhead.

Bacteriological Report. Cultures from the heart blood show staphylococcus pyogenes aureus. Liver, spleen, lung and pericardium show the same.

Microscopic Examination. The cells of the tubules of the cortex show some swelling and granulation. There are a few small abscesses apparently originating in glomeruli. One or two of the convoluted tubules show beginning abscess formation.

Sections Stained for Bacteria show large numbers of staphylococci in the abscesses. Staphylococci are found in the tufts of glomeruli, capsule of Bowman, tubules, and a few in the lymph spaces. Small abscesses in the lower tubules show the cocci mostly confined to the lumen of the tubule.

Case 9. *Autopsy* No. 2784. East Surgical 712-291. Male, 49, January 28, 1911.

Present Illness. Uremia, hematuria and pyuria at entrance to hospital. *Urine examination* not recorded. *Temperature* 99°; *white blood count* 18,000.

Cystoscopy showed inoperable carcinoma of the bladder. Patient died the following day.

Clinical Diagnosis. Uremia, carcinoma of the bladder, infected kidneys.

Autopsy. 6¾ hours post mortem. *Anatomical Diagnosis*: Carcinoma of the bladder. Pyonephrosis. Suppurative nephritis. Perinephritic abscess. Soft spleen.

Kidneys. Right kidney weighs 260 grams. The perinephric tissue is markedly thickened and shows extensive infiltration with pus. The capsule strips with difficulty, leaving an ir-

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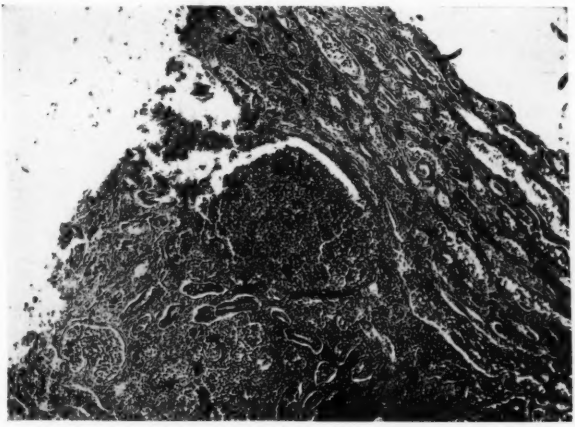

Fig. 13. One of a small cluster of cortical abscesses, all of which seem to take origin from glomeruli. Photo by L. S. Brown x 70.

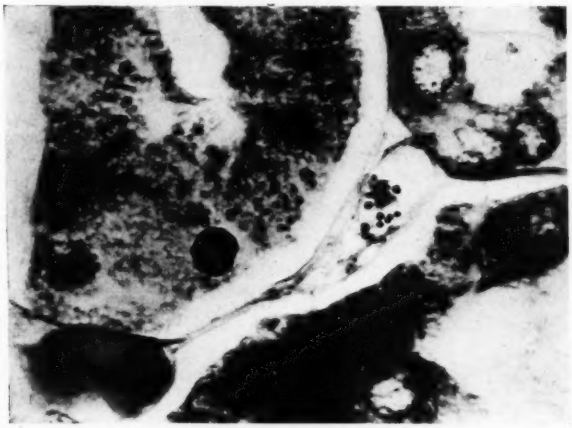

Fig. 14. Microphotograph showing staphylococci in the blood stream of the cortical portion of the kidney. Photo by L. S. Brown x 1,500.

regular surface dotted over with numerous minute yellow points which yield pus. The cortex is 5-8 mm. On section the surface shows minute collections of pus situated mainly in the cortical region. The pelvis and ureter are slightly dilated. The right ureter is somewhat occluded by a new growth of tissue in the bladder. The left kidney weighs 193 grams. The perinephric tissue is greatly thickened and shows extensive infiltration with pus. The capsule strips leaving a lumpy surface dotted over with abscesses. The cortex measures 5-6 mm. Section surfaces show minute collections of pus mainly in the cortical region. In some places the tubules are dilated. The calices show yellow necrotic flakes. The left ureter is dilated and partly occluded by new growth of bladder. The bladder mucosa is inflamed. The prostate is not enlarged. The upper part of the organ is involved in a new growth of the bladder wall which extends down onto the posterior portion of the prostate.

Microscopic Examination of the kidney is not recorded.

Bacteriological Report. Culture from heart blood. No growth.

Sections Stained for Bacteria show no bacteria other than staphylococci. They are found in the lymph spaces and within the lumens of tubules, sometimes phagocyted in the epithelium of the tubules, and diffusely in the abscesses. No bacilli are seen in the kidney tissue. There are a few lying free in the pelvis.

Case 10. *Autopsy* No. 2381. South Surgical CLXXXII-189. Male, 24. June 12, 1909.

Present Illness. Injury to right forearm eight days ago. Three days ago became delirious. Arm much swollen. *Blood cultures* showed staphylococcus pyogenes aureus. *Cultures from arm,* staphylococcus aureus. *Urine examination* not recorded. *White blood count,* 17,200. *Temperature,* 103-108°. Died second day after entrance.

Clinical Diagnosis. Septicemia, septic wound.

Autopsy. 17⅔ hours post mortem. *Anatomical Diagnosis*: Septic wound of forearm, right. Multiple abscess of myocardium, liver, kidneys, brain. Acute splenic tumor.

Kidneys. Combined weight 312 grams. Capsules free. The surfaces marked by numerous round and oval abscesses surrounded by reddish zones. The stellate veins are injected. On section cortex is of normal thickness. Both cortex and medulla show numerous fairly sharply circumscribed round spots, many of them surrounded by reddish zones. Both kidneys present practically the same picture. The bladder shows injected mucosa and dark colored areas. Pelves and ureters are normal. *No microscopic examination* or *bacteriological report* is recorded. *Sections stained for bacteria* show large numbers of staphylococci found only within the small abscesses.

Case 11. *Surgical Case* No. 712-90. South Surgical CLVII-307. Male, 28. December 24, 1907.

Past History. Gonorrheal infection one year ago.

Present Illness. For three weeks has had hematuria and pyuria with dull aching pain in the right kidney. No stricture.

Urine, acid, large trace of albumin, pus and blood. *Temperature,* 100°. *Operation,* nephrectomy with drainage. Uneventful recovery. *Clinical Diagnosis.* Focal suppurative nephritis. *Pathological Report.* Large kidney fibrous at one end with abscess. Several small purulent foci scattered through the substance.

Sections Stained for Bacteria. Only staphylococci present; these are found only in abscesses.

Case 12. *Autopsy* No. 138. East Surgical vol. 328, pp. 77, 177, 176. Male, 62. July 9, 1897.

Diagnosis. Carcinoma pancreas. *P. H.* Eight years ago had pain in right lumbar region referred to groin and testes. *P. I.* Admitted to the hospital for gastric symptoms.

Urine Examination. On admission, slight trace albumin, occasional pus cell, no casts.

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Fig. 15. Section through a glomerulus at the point of entry of the capillary into the glomerulus to form the tuft. Portions of the capsule of Bowman are seen at a—a. Note large number of cocci entering the glomerulus in the blood stream. Photo by L. S. Brown x 1,500.

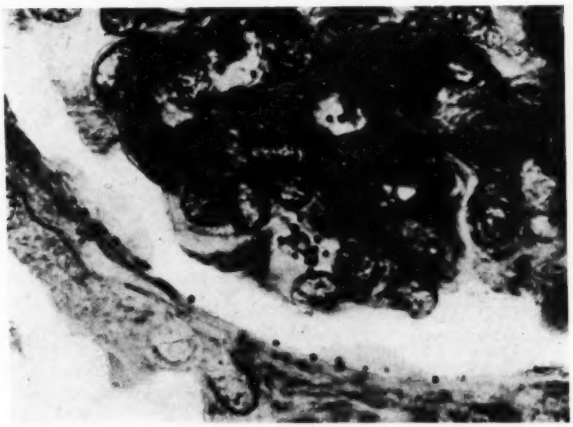

Fig. 16. Edge of a glomerulus showing staphylococci in the lumen of the capillary and also free in the capsule of Bowman. There is no evidence of rupture of the capillary in this glomerulus. Photo by L. S. Brown x 1,500.

Operation. Exploratory laparotomy for carcinoma of pancreas. Operation wound became septic. Small abscesses developed about stitch holes with miliary abscesses in deep fat throughout the length of the wound. Continued temperature after operation ranging from 100° to 103°. After one month from operation patient's wound gradually became cleaner, showing good granulations. The patient, however, continued to lose ground, becoming progressively weaker. Temperature again rose. Developed phlebitis right leg, spasticity right hand and arm and swelling of left parotid region. Died on the 38th day.

Autopsy. 7 hours post mortem. *Anatomical Diagnosis.* Carcinoma pancreas and adjacent glands. Involvement of the liver and glands along the abdominal aorta and iliac vessels. Abscess in tissue of the abdominal wall. Acute purulent phlebitis. Edema of lungs with abscesses of upper right lobe and lower left lobe. Degeneration of the kidneys with subacute abscess formation.

Kidneys. Enlarged. Combined weight 544 grams. Cortices 5-7 mm. Capsules strip with a few adhesions. Surfaces yellowish red with thickly sown pinhead to bean-sized areas, yielding on section white semi-fluid pus. These areas more numerous in the right kidney. On section the pelvis is not remarkable. The markings are indistinct in places. Scattered through the tissue are small yellowish areas and patches mostly in or near the cortex. In the left kidney, but also showing everywhere in the right kidney, are yellowish streaks extending down from the cortex into the pyramids.

Bladder shows nothing abnormal.

Bacteriological Report. Cultures from the heart blood, liver, kidneys, pleura, spleen and pus in the peritoneal cavity show staphylococcus pyogenes aureus. Pus from the peritoneal cavity shows in addition bacillus coli communis.

Microscopic Examination shows a few scattered darkly stained areas equally distributed through the cortex and

pyramids. These areas are on the average the size of a pinhead. In the pyramids they seem elongated in the direction of the tubules. On examination they are seen to consist of numerous pus cells closely packed together, in the midst of which remains of kidney structures are rather faintly indicated. Interspersed among the pus are small granulation tissue cells. This condition would indicate that the process had lasted for some time. These areas are abscesses in the process of healing. Considerable granular detritus and colorless ring-like bodies lie in the lumen of the tubules. No emboli made out.

Sections Stained for Bacteria. Right kidney shows in one corner of the section several small abscesses two or three times the size of a glomerulus all of which seem to take origin from glomeruli or the neighboring proximal convoluted tubules (Fig. 13). In the centers of these areas are large masses of staphylococci. There are many new connective tissue cells within the abscesses. Surrounding the abscess areas there is a diffuse infiltration with new connective tissue cells and polynuclear leucocytes. Many of the tubules leading towards the pelvis from these areas show plugs of pus and desquamated epithelial cells thickly studded with phagocyted bacteria. In the region of the distal convoluted tubules such bacterial plugs are seen to form the centers of small abscesses. Throughout the remainder of the section the tissue is for the most part unchanged. In some areas, however, there is considerable desquamation of the epithelium of the tubuli contorti. In all such portions of the sections the blood vessels are seen to contain large numbers of staphylococci, most of which are within the leucocytes (Fig. 14). In several areas the capillaries entering the glomerulus and the tuft of the glomerulus contain large numbers of staphylococci (Fig. 15). In the glomeruli the staphylococci are seen lying in the capillaries and also free in the capsule of Bowman (Fig. 16). In none of these glomeruli was there any extravasation of blood into the

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Fig. 17. Microphotograph showing origin first portion of tubule. The glomerulus lies above and to the left. At (a) is to be seen a staphylococcus in diplococcus form entering the first portion of the tubule. The remaining particles are artefacts due to precipitated Gram stain. Photo by L. S. Brown x 1,500.

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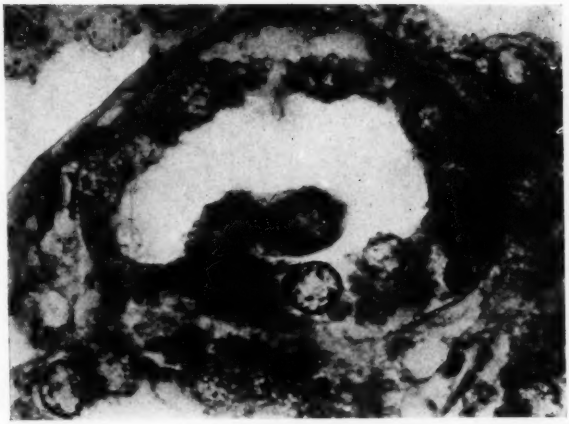

Fig. 18. A section of the proximal convoluted tubule showing a triad of staphylococci in upper left hand portion of tubule and a clump of cocci on the opposite side. Note the presence of these cocci in the protoplasm of epithelial cells. Photo by L. S. Brown x 1,500.

capsule indicating a rupture of the capillary. In one of the glomeruli, in which a fortunate plane of section shows a considerable portion of the first part of the tubule, bacteria are seen not only lying in the capsule of Bowman but entering the tubule (Fig. 17). In all portions of the convoluted tubules considerable numbers of bacteria are seen in the tubules but mostly contained *within the epithelial cells* (Figs. 18 and 19). In the straight collecting tubules bacteria seem always to lie in the lumens of tubules. In the pelvis staphylococci and bacilli are found. The pelvic mucosa looks normal. Some few bacteria are to be found in the interstitial tissue most of them lying in the lymph spaces.

Note. This kidney seems to indicate that there have been two general infections. In the first there was considerable abscess formation resulting, which had begun to heal. There seems in addition to have been a severe septicemia, many bacteria from which are seen in the process of excretion through undamaged glomeruli.

Case 13. *Autopsy* No. 322. West Medical 510-162. Male, 69. September 19, 1898.

Present Illness. Has been sick for two weeks with dyspnœa as chief complaint.

Physical Examination shows nothing of interest save high temperature and abscess back of neck. *White blood count,* 82,000. *Urine,* acid, cloudy; albumin, slight trace; sediment, few hyaline casts, blood, leucocytes. Died fourth day.

Discharge Diagnosis. Septicemia. Abscess of neck.

Autopsy. 6 hours post mortem. *Anatomical Diagnosis*: Phlegmon right shoulder. Multiple abscesses lungs. Suppurative nephritis with infarctions. Acute hyperplasia spleen. Decubitus.

Kidneys. Capsules free, cortex of normal width, markings retained. Here and there in the pyramids and in the cortex are a few gray, opaque pinhead-sized points. In one kidney there is a large wedge-shaped area extending from the base

of a pyramid upwards to the capsule. The tissue is opaque, pale, and the outline is marked by a gray zone. Pelves, ureters and bladder normal.

Microscopic Examination. Micrococci seen in the abscesses. In one or two instances plugs of micrococci are found in the small vessels. Cultures from the carbuncle in the back show staphylococcus pyogenes aureus. Heart blood, spleen, liver and kidney the same.

Sections Stained for Bacteria. One area, the small pyramidal area of suppuration, apparently takes origin from a bacterial embolus in a small artery. In other instances the glomeruli are clearly the seat of abscess formation, while in still others plugs of bacteria are found in the lumens of tubules surrounding which there is a narrow area of necrosis of epithelium, outside of which is infiltration with polynuclear leucocytes. In still other areas staphylococci singly or in small groups are found in the arterioles entering glomeruli. In the glomeruli they are found within the capillaries, and in the tubules in many cases phagocyted within epithelial cells of the convoluted portion. In some instances bacteria are seen within epithelial cells in apparently normal tubules.

Case 14. *Autopsy* No. 2597. West Medical 762-47. Male, 65. May 2, 1910.

Present Illness. Eleven months' painful and difficult urination; brown, cloudy urine. Four months' severe gastric symptoms suggestive of cancer.

Temperature, normal at entrance.

Urine, alkaline, albumin slight trace, occasional cast. No urine culture recorded. Four days later, without apparent reason, began to have hematuria with small amount of pus, accompanied by rise of temperature to 105.5° and died the third day following.

Autopsy. 18 hours post mortem. *Anatomical Diagnosis:* Adeno-carcinoma of stomach. Multiple carcinoma of small intestines. Chronic nephritis. Suppurative nephritis of right

kidney. Renal and ureteral dilatation. Arteriosclerosis. Cholelithiasis. Small fibroma of bladder wall.

Kidneys. Combined weight 200 grams. Left kidney, capsule strips but is somewhat adherent. Cortex is ½ mm. in width. Left ureter is slightly dilated along its entire course but opens freely into the bladder. The mucosa is negative. Right kidney capsule strips with some fine adhesions. The granular surface is dotted over in many places with minute yellow spots. On section the tissue is firm, cortex extremely narrowed. The yellow spots described as present on the surface project down into the kidney tissue as minute small reddish irregular areas. The pelvis is slightly dilated. The mucosa is smooth. The right ureter is dilated; its mucosa is smooth; and opens freely into the bladder. The bladder mucosa is not remarkable save that in one area there is a round minute pedunculated mass springing from the mucosa. The prostate is negative.

Microscopic Examination. There is marked fibroid atrophy of the renal tissue with much arteriosclerosis, extensive suppuration and destruction of renal tissue in the surrounding areas.

Bacteriological Report. Cultures from spleen show question of bacilli.

Sections Stained for Bacteria show only staphylococci. These are found in abscesses and a few in the tubules within the protoplasm of a clump of pus cells.

Case 15. *Autopsy* No. 2998. West Medical 814-201. Male, 64. February 7, 1912.

Past History. Boils on the shoulder three years ago. For six years has had diabetes.

Present Illness. Sore toe of two weeks' duration. Coma.

Physical Examination shows diabetic gangrene. *Temperature* normal.

Urine much free blood and pus, slight trace of albumin,

sugar, acetone, and diacetic present. Patient sent to ward where he promptly died.

Clinical Diagnosis. Diabetes, acidosis, coma.

Autopsy. 19¼ hours post mortem. *Anatomical Diagnosis*: Diabetes. Arteriosclerosis. Abscess of prostate. Amyloid kidneys. Gangrene of toe. Soft spleen. Small abscess of kidney. Staphylococcus septicemia.

Kidneys. Combined weight 540 grams. Capsules strip leaving smooth surface save in one point on the right kidney where there is a collection of fibrino-purulent material which extends into the perinephric fat. The cortices are not narrowed. In the substance of the right kidney a short distance below the collection of pus on the surface there is a small dark red area, the central portion of which is soft. The ureters are free. The bladder shows hypertrophy of the trabeculæ and the mucosa of the trigonum shows swelling and dirty reddish discoloration, with here and there minute yellowish soft areas. The prostate is slightly enlarged and shows numerous small areas of pus throughout the organ. They are most numerous in the middle lobe and extend up beneath the trigonum. *Cover glass preparations* from the prostatic pus show staphylococcus.

Microscopic Examination. Kidneys show amyloid infiltration of the small arteries and glomeruli, edema with some areas of necrosis and pus cell infiltration. Sections of the prostate show suppuration and abscess formation.

Bacteriological Report. Cultures from the heart blood show many colonies of staphylococci.

Sections Stained for Bacteria show staphylococci alone in the small abscess cavity.

Case 16. *Autopsy* No. 2262. West Medical 712-95. Female, 45. November 30, 1908.

Past History. Negative save for polyuria five years ago, at which time diagnosis of diabetes made.

PLATE XXVI—Presented by Drs. Hugh Cabot and E. G. Crabtree

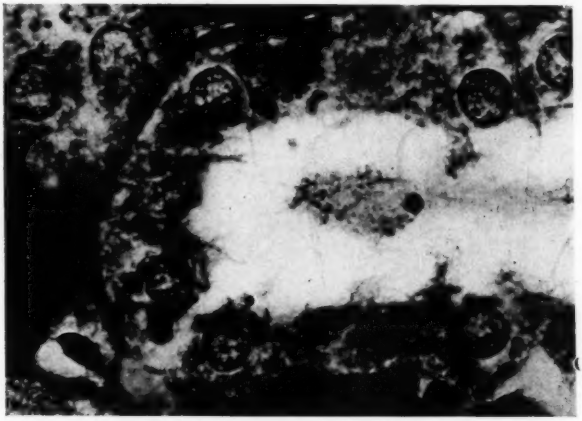

Fig. 19. Portion of distal convoluted tubule showing many staphylococci phagocyted by epithelial cells. A group of cocci free in the lumen of a neighboring tubule are to be seen in the upper left hand corner of the picture. Photo by L. S. Brown.

Fig. 20. Small anæmic infarct of cortex showing cross section of artery plugged with a septic embolus. A branch of the artery also thrombosed and containing bacteria is to be seen at the lower edge of the infarcted area. Photo by L. S. Brown x 40.

Present Illness. Patient comes in for abnormal menstruation.

Urine. Acid, no albumin, sugar acetone or diacetic present, moderate amount of pus. Patient put on very strict diabetic diet. Patient continued comfortable except hungry for 15 days, at which time she became drowsy, developed a slight cough and scattered râles in the lungs and died on the 17th day.

Clinical Diagnosis. Diabetes, acidosis, endometritis.

Autopsy. 14½ hours post mortem. *Anatomical Diagnosis*: Glycosuria. Tuberculosis of left lung. Soft spleen. Suppurative nephritis with miliary abscesses of right kidney.

Kidneys. Combined weight 385 grams. Capsules strip easily save over an area of the right kidney where there is a reddened spot 5 mm. in diameter. This area is dotted with minute abscesses. *Cover glass preparation* from pus is negative for tubercle bacilli. On section the remaining tissue of the kidney is firm, markings are visible, cortex is not narrowed, the pyramids are brownish red and show indefinite minute yellow areas in places. Bladder, ureters and pelves are not remarkable.

Microscopic Examination. In two sections of the kidney there are abscesses with suppurative infiltration. There is no tuberculosis.

Bacteriological Report. Cultures from the heart blood and spleen show no growth.

Sections Stained for Bacteria show some hemorrhagic glomeruli in which are cocci in very small numbers. An occasional group of cocci can be found in the lumens of tubules low down towards the tips of the pyramids and a few in the pelvis. The sections preserved from this kidney show no abscesses.

Case 17. *Autopsy* No. 1828. East Surgical 554-275. Male, 29. November 25, 1906.

Present Illness. Carbuncle upper lip five days' duration. Intense edema, fever. No renal tenderness or masses.

Temperature 104°.

Urine. Negative but no sediment done. Patient died third day.

Clinical Diagnosis. Carbuncle of lip, septicemia.

Autopsy. 6 hours post mortem. *Anatomical Diagnosis*: Carbuncle of lip. Multiple abscess of the lung with empyema. Suppurative infiltration of the anterior and superior mediastinum. Suppurative nephritis. Acute hyperplasia of spleen. Staphylococcus pyogenes aureus septicemia.

Kidneys. Combined weight 360 grams; capsules slightly adherent. There are three or four minute suppurative foci in the kidneys. The cortices are normal in width and the markings retained. The bladder and ureters are not remarkable.

Microscopic Examination. There is cloudy swelling of the epithelium of the tubules.

Bacteriological Report. Cultures from the heart blood and spleen show staphylococcus pyogenes aureus.

Sections Stained for Bacteria show large clumps of staphylococci within the abscesses, none in any other part of the section.

Case 18. *Autopsy* No. 1201. South Surgical XCI-255. Female, 43. March 16, 1904.

Present Illness. Recent pneumonia followed by empyema with symptoms of brain abscess of two weeks' duration.

Urine examination at admission negative; thirteen days later slight trace of albumin, small amount of blood and pus.

Operation. Exploration of old empyema. Following operation patient became unconscious and general paralysis developed. Patient died thirty-third day.

Clinical Diagnosis. Empyema, brain abscess.

Autopsy. Anatomical Diagnosis: Abscess of brain. Chronic empyema left with sinus communicating with the splenic flexure of the colon. Sub-diaphragmatic abscess.

Ulcer of stomach with secondary carcinoma. Abscess of kidney. Operation wound.

Kidneys. The kidneys are of normal size; capsules strip. At one point in the surface of one of the kidneys is a small abscess which extends a short distance into the kidney tissue. The bladder and ureters show nothing abnormal.

Microscopic Examination. Kidney sections show rather extensive degeneration of the renal elements.

Bacteriological Report. Cover glass preparations from the pus of the brain abscess show leucocytes, staphylococci, streptococci and bacilli.

Cultures from the heart blood show no growth; liver shows many colonies of colon-like bacilli and a few streptococci; spleen shows slight growth of colon-like bacilli.

Sections Stained for Bacteria show clumps of staphylococci in abscesses, none found in the tubules or pelvis.

Case 19. *Autopsy* No. 1093. West Surgical 441-45. Female, 53. June 15, 1903.

Past History. Negative as to G.-U. tract.

Present Illness. Five years ago gall-stone symptoms.

Urine examination on admission negative.

Operation. Cholecystotomy with drainage of common duct. Slight sepsis of wound occurred. During convalescence swelling of right parotid gland which was later incised. Patient died on the thirty-fourth day.

Clinical Diagnosis. Gall-stones and pyemia.

Autopsy. 14½ hours post mortem. *Anatomical Diagnosis*: Cholecystotomy with open bile duct. Subcutaneous abscess of the walls of the wound. Phlegmon of neck. Abscesses of kidneys. Septicemia staphylococcus pyogenes aureus.

Kidneys. Weight is not mentioned; capsules strip easily. In two or three places in each kidney the surface shows several small abscesses which extend a short distance into the kidney substance. *Cover glass preparations* from the pus of

these abscesses show leucocytes and staphylococci. Ureters and bladder show nothing worthy of note.

Microscopic Examination. Sections from the kidneys show abscesses.

Bacteriological Report. Cultures from the heart, liver, spleen, skin abscesses and kidney abscesses show growth of staphylococcus pyogenes aureus.

Sections Stained for Bacteria. The abscess cavities show large clumps of staphylococci, no other bacteria seen.

Case 20. *Autopsy* No. 1039. West Medical 584-40. Male, 38. March 15, 1902.

Present Illness. Seven weeks ago began to feel poorly, slight gastric symptoms, restlessness at night. Two weeks later gave up work. Still later he began to develop pain and local areas of soreness in the left arm. Temperature at entrance 100° and continued as a high septic temperature.

Physical Examination. Large abscess of right shoulder, another over sacrum. On back and extremities numerous small semifluent abscesses. Pus from abscesses showed staphylococcus pyogenes aureus. *White blood count* 26,000.

Urine. Acid; albumin, slightest possible trace; sediment, rare casts but some with pus cells adherent; few pus cells, much epithelium. Patient continued with high fever until death on the fifth day.

Clinical Diagnosis. Pyemia, multiple abscesses.

Autopsy. 39½ hours post mortem. *Anatomical Diagnosis*: Multiple abscesses of the liver. Thrombosis of hepatic vein. Multiple abscesses of lungs, kidneys and subcutaneous tissue of extremities and trunk. Hyperplasia of spleen. Purulent otitis media. Septicemia—staphylococcus pyogenes aureus.

Kidneys. Combined weight 416 grams. Capsules free. Scattered throughout the substance of each kidney are several small abscesses containing pus. Some of these are arranged in more or less confluent groups. Cortices of normal

PLATE XXVII—Presented by Drs. Hugh Cabot and E. G. Crabtree

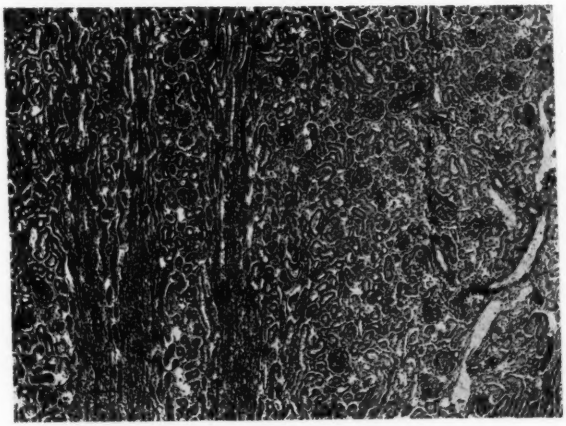

Fig. 21. Typical area from the kidney of a child with chronic pyelonephritis which now presents the picture of a pure pyelitis. The kidney tissue is normal throughout. Photo by L. S. Brown x 45.

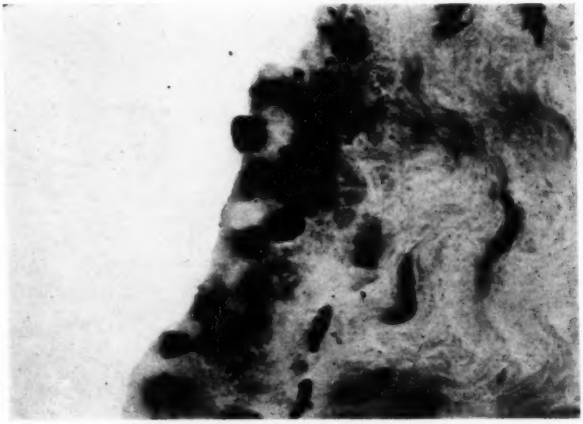

Fig. 22. Microphotograph of portion of pelvis (same case as Fig. 21) showing slight thickening mucosa without submucous change and large numbers of colon bacilli growing in the mucosa. Photo by L. S. Brown x 1,500.

width with markings retained. Bladder, prostate and ureters normal.

Microscopic Examination. Aside from the abscesses of the kidney, the renal tissue is not remarkable.

Bacteriological Report. Cultures from the heart, liver, and spleen, abscesses of the right kidney, hip and left ankle show profuse growth of staphylococcus pyogenes aureus. *Cover glass preparations* from these abscesses show staphylococci but no other bacteria.

Sections Stained for Bacteria. Abscess cavities contain clumps of staphylococci, no other organisms.

Case 21. *Autopsy* No. 986. East Medical 573-138. Female, 52. December 22, 1902. *Past History.* Negative.

Present Illness. Eight days ago symptoms of acute infection with vomiting, loss of appetite, shortness of breath, and urinary incontinence.

Physical Examination. Considerable fluid in abdomen, evidence of fluid in both chests. Question of tumor mass in abdomen. Temperature normal and remained so. White blood count 62,000.

Urine. Acid, slight trace of albumin, moderate amount of pus. Abdominal fluid exudate shows polymorphonuclear leucocytes. A few cocci in abdominal fluid. Patient died suddenly on third day.

Diagnosis. Ovarian cyst, septicemia and pyemia.

Autopsy. 6 hours post mortem. *Anatomical Diagnosis*: Cystomata of the ovaries with suppuration and gangrene. Compression and dilatation of the right ureter. Suppurative nephritis of the right kidney.

Kidneys. Left kidney somewhat larger than right. Capsule strips. Cortex narrow markings retained. On the surface of the right kidney are a number of whitish slightly elevated areas which on section show purulent material. These areas are not sharply outlined from the surrounding renal

tissue and show some tendency to extend in the form of streaks into the cortex.

Microscopic Examination. On section kidney shows an area of injected renal tissue infiltrated with polynuclear leucocytes. The renal tubules appear to be disintegrated.

Bacteriological Report. Cultures from the heart and spleen no growth; from liver two colonies of b. coli communis. Peritoneal exudate shows b. coli communis, b. aerogenes capsulatus and staphylococci.

Sections Stained for Bacteria show a few staphylococci in one of the tubules. There are no abscesses in the section preserved.

Case 22. *Autopsy* No. 813. South Surgical LX-64. Male, 31, January 6, 1902. *Past History.* Gonorrhea twice.

Present Illness. Appendix symptoms of three weeks duration with abscess at time of entrance to hospital.

Urine. At entrance showed slight trace of albumin; sediment showed pus and very many casts, some with pus cells adherent. Septic temperature ranging from 100° to 104°. White blood count 43,000. Free pus in the abdomen, cultures from which showed staphylococcus pyogenes aureus. Patient died on the nineteenth day after admission.

Clinical Diagnosis. Appendix abscess, septicemia.

Autopsy. 13¾ hours post mortem. *Anatomical Diagnosis*: Gangrenous appendicitis with abscess formation with perforation and gangrene of cecum. Suppurative phlebitis ileocolic and superior mesenteric veins. Suppurative thrombophlebitis portal vein. Multiple abscess liver. Abscess right kidney. Laparotomy wound. Acute hyperplasia spleen. Streptococcus septicemia.

Kidneys. Combined weight 203 grams. Capsules strip. Cortex measures 6 mm. The pyramids are dark reddish in color. The substance of the right kidney in the pyramidal portion discloses on section a small collection of pus. No areas of suppuration found in the left kidney. Ureters, blad-

der, prostate, seminal vesicles and testes are not remarkable.

Microscopic Examination. A fairly large section of the kidney fails to show any lesion worthy of mention.

Bacteriological Report. Liver and spleen show profuse growth of bacilli of the colon group. In the water of condensation, numerous micrococci and a number of streptococci. Cultures from the liver at the time of operation show innumerable colonies of staphylococcus pyogenes aureus.

Sections Stained for Bacteria. There are no abscesses in the section preserved. In one of the collections of leucocytes in a tubule a few staphylococci are found, too few to make any estimate as to the nature of the infection.

Case 23. *Autopsy* No. 1065. East Surgical 440-269. Male, 1½ years. May 16, 1903.

Past History. Infectious diarrhea at eleven months.

Present Illness. Two days ago fell and bruised forearm. Has had chills and fever since then. *Temperature* 104°. *Urine* not recorded. *Operation.* Incision and drainage of forearm. Culture from forearm showed staphylococcus pyogenes aureus. Death on second day.

Clinical Diagnosis. Septic periostitis, pyemia. *Autopsy.* 19½ hours post mortem. *Anatomical Diagnosis*: Septic right forearm. Multiple abscesses lungs, kidneys and myocardium. Septicemia staphylococcus pyogenes aureus.

Kidneys. Combined weight 95 grams. Capsules strip easily. On the surface of both kidneys are a few small yellowish abscesses. *Cover glass preparations* from the purulent material in one of these abscesses show numerous staphylococci—no other bacteria.

Microscopic Examination. The section examined shows a small abscess.

Bacteriological Report. Cultures from the heart show many colonies of staphylococcus pyogenes aureus. Cultures from the liver and spleen show staphylococcus pyogenes aureus and colon-like bacilli.

Sections Stained for Bacteria. Staphylococci only are found in the small abscess area. There are no bacilli in the pelvis.

Case 24. *Autopsy* No. 1363. East Surgical 504-169. Male, 64. April 6, 1905.

Present Illness. Recent open fracture of ankle and fracture of ribs.

Urine. First examination negative; second examination two weeks later, albumin small trace; sediment much pus.

Admission temperature, 101°, rose to 103°-104°, maintained until death on twenty-fourth day. Streptococci in wound.

Clinical Diagnosis. Compound fracture of ankle, streptococcus wound, streptococcus septicemia.

Autopsy. 18½ hours post mortem. *Anatomical Diagnosis*: Compound comminuted fracture of right ankle. Fracture of ribs. Purulent infiltration of deep tissues of the right leg. Slight suppurative nephritis. Streptococcus septicemia.

Kidneys. Capsules strip revealing numerous small cortical cysts. The markings are obscured. The ureters are free. The bladder and prostate are not remarkable.

Microscopic Examination. A small papillary adenoma of the kidney is present, also occasional areas of fibroid atrophy with cyst formation. In two or three places are small suppurative areas.

Bacteriological Report. Cultures from the heart blood and spleen show streptococcus pyogenes. Cultures from the liver show a few streptococci and many colon bacilli.

Sections Stained for Bacteria. A few chains of streptococci are found in the blood vessels of the kidney and in the areas of suppuration above mentioned.

Case 25. *Autopsy* No. 2854. West Medical 784-186. Female, 44. February 23, 1911. *Past History.* Long standing anemia.

Present Illness. Still continues weak with a variety of

PLATE XXVIII—Presented by Drs. Hugh Cabot and E. G. Crabtree

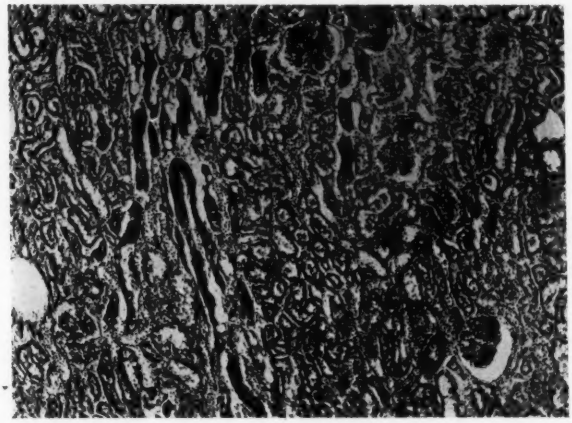

Fig. 23. Typical appearance of the kidney of a chronic colon bacillus pyonephrosis, the result of a pyelitis of infancy. Note moderate lymphocytic infiltration and extensive damage to convoluted tubules. The glomeruli are unchanged. Photo by L. S. Brown x 45.

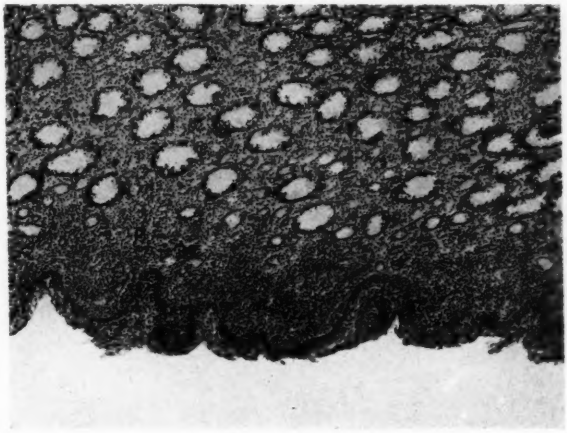

Fig. 24. Pelvis of same case as in Fig. 23 showing thickened mucosa and submucosa, increase in interstitial tissue and dilated collecting tubules of the pyramid. The submucosa is extensively infiltrated with lymphocytes and an occasional pus cell. Colon bacilli are numerous in the mucosa, rare in the remainder of the kidney. Photo by L. S. Brown x 45.

symptoms, chiefly of dyspnoea and gastro-intestinal upsets. *Physical examination* shows anemia and cardiac lesions.

Urine at entrance negative save for unexplained small trace of albumin.

Temperature continued as it had been before, a slight evening increase to 99°-100°. Was given 0.6 gram 606 intramuscularly in left gluteal region followed by vomiting and soreness in the buttocks and induration with some increase of temperature. Twenty days later still some induration about site of injection of salvarsan. One month after entrance to hospital urine began to show blood and pus in small amounts. Lungs show signs of edema. Condition thought to be arsenic poisoning and excision of residum of 606 done. Wound discharged freely and sloughed. Patient died at the end of four months.

Clinical Diagnosis. Pernicious anemia, arsenic poisoning, emaciation.

Autopsy. 15 hours post mortem. *Anatomical Diagnosis*: Arteriosclerosis. Nephritis with foci of suppuration. Septicemia streptococcus.

Kidneys. Right kidney weighs 116 grams: capsule adherent. The configuration of the organ is distorted by the presence of two large depressed areas corresponding to areas of extensive atrophy of the renal tissue. About one quarter of the volume of the kidney is involved in this area. The renal tissue outside of this area shows obscure markings, and the line of demarcation between cortex and pyramids cannot be made out. There is distortion of the pelvis due to areas of atrophy. The left kidney weighs 51 grams. Its capsule is extremely adherent and thickened. Marking of the cortex cannot be made out and the line of demarcation between the cortex and kidneys is not clear. At one point the renal tissue over an area of 1 cm. is extremely tough and fibrous in character. The pelvis, ureter and bladder are not remarkable.

Microscopic Examination. Section from the non-atrophic

portion of the kidneys shows large tubules and glomeruli. The failure to observe the usual cortical markings at autopsy was probably due to improper incision owing to obscuration of the parts. A second section shows a zone of extreme atrophy extending along beneath the capsule. There is extreme sclerosis of the vessels in this area. At one point there is an area of suppuration in the cortical region. In the left kidney there are several areas of suppuration in the tissue.

Bacteriological Report. Cultures from the heart blood show moderate growth of streptococci.

Sections Stained for Bacteria show streptococci only. They are located in the tufts of the glomeruli and occasionally in the lymph spaces. Glomeruli containing streptococci show mild glomerular changes.

Case 26. *Autopsy* No. 2344. Neurological III-119. Male, 39. February 20, 1909.

Past History. Two years ago right leg torn and crushed in an accident; an abscess formed which was later opened.

Present Illness. For past six weeks numbness of both feet which gradually extended upwards involving the body from the lower half of the abdomen down. Diagnosis of myelitis.

Urine, at time of entrance, hazy, alkaline, slight trace of albumin and a few pus cells.

Temperature normal and remained so during the first thirty days of patient's stay in the hospital at which time he developed bed sores, erysipelas and septic foot. Died forty-second day.

Clinical Diagnosis. Myelitis, cystitis, erysipelas, bed sores, septic foot.

Autopsy. 15½ hours post mortem. *Anatomical Diagnosis*: Erysipelas. Decubitus. Hypertrophic bladder and ureters. Cystitis. Ureteritis. Pyonephrosis. Early suppurative nephritis. Chronic pericarditis. Ulcer sole of right foot. Combined tract degeneration of the spinal cord. Streptococcus septicemia.

PLATE XXIX—Presented by Drs. Hugh Cabot and E. G. Crabtree

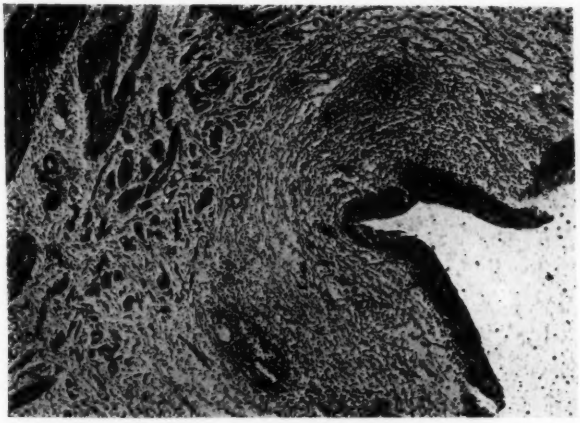

Fig. 25. Section of ureter from case shown in Figs. 23 and 24 showing thickened mucosa and submucosa with two collections of cells in the submucosa. There are few pus cells in the submucosa. Bacteria along with pus cells are found in the mucosa. Photo by L. S. Brown.

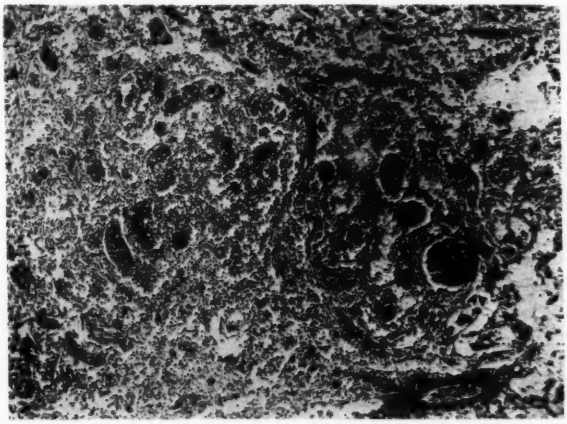

Fig. 26. Typical picture of pyelonephritis due to the colon bacillus in a case in which the conditions requisite for ascending infection were present. Note normal glomeruli, dilated tubules filled with pus, and desquamated epithelium and moderate interstitial infiltration with lymphocytes and a few pus cells. Photo by L. S. Brown x 45.

Kidneys. Normal size; the capsules are slightly adherent. The surfaces are smooth and show few small depressions, some of which are pale in color. Markings are retained. Cortex is somewhat narrowed. The pelves and calices are dilated and the papillæ are slightly flattened. Pelvic mucosa is reddened. The ureters are markedly dilated and their walls thickened. The mucosa shows injection. The bladder is thick and red.

Microscopical Examination. The sections show areas in which the renal tissue is infiltrated with plasma cells, lymphacytes and leucocytes, and the renal tissue is disintegrated. The leucocytes are generally in the minority, which may be regarded as indicating a beginning suppuration.

Bacteriological Report. Cultures from the heart blood show a growth of streptococci.

Sections Stained for Bacteria show a few streptococci in the blood vessels and one or two of the glomeruli. The section preserved from the autopsy contained no abscesses.

Case 27. *Autopsy* No. 1222. East Medical 607-14. Female, 25. April 29, 1904.

Present Illness. Three months ago for no apparent reason left leg became swollen and has remained so. Has had considerable abdominal and gastric distress with vomiting. Irregular septic temperature normal to 100° with premortal rise.

Urine. Acid, albumin slight trace, numerous epithelial cells, leucocytes and red blood corpuscles. White blood count 6800. Patient later developed suppression of urine. White count increased to 13,600, urine became alkaline in reaction, abdomen extremely tender and distended. Patient suddenly became comatose and died at the end of the thirty-second day.

Clinical Diagnosis. Thrombosis of left thigh.

Autopsy. 15¼ hours post mortem. *Anatomical Diagnosis:* Syphilitic or tuberculous tumors of both groins and retroperitoneal tissue constricting the left ureter. Thrombosis in

the inferior vena cava. Left hydronephrosis with dilatation of ureter. Chronic interstitial nephritis. General fibrinopurulent peritonitis. Chronic pelvic peritonitis. Streptococcus septicemia. Abscess foci, necrosis and thrombi in branches of right renal vein and kidney.

Kidneys. Right kidney weighs 145 grams, left 78 grams. Right kidney capsule strips leaving smooth surface showing in several places slightly depressed reddish yellow to black areas. On section these areas are seen to be the outer surfaces of small streaks and rounded masses (infarcts) which extend a short distance into the kidney tissue. They are well marked off from the surrounding kidney tissue. The pelvis is very slightly increased in size and the mucosa shows a few small reddish areas. The ureter is normal save for fibrous thickening of the periureteral tissue along its upper half. The left kidney capsule is slightly adherent in places. On section the pelvis is markedly dilated and at its middle third is lost in a mass of fibrous tissue. The lower third of the ureter is normal in size.

Microscopic Examination. Kidneys show rather diffuse increase of interstitial connective tissue, most marked in the left. In the right kidney branches of a renal vein contain thrombi. The kidney shows areas of necrosis and one abscess.

Bacteriological Report. Cultures from the heart, blood and spleen show profuse growth of streptococcus pyogenes.

Sections Stained for Bacteria show the pyramidal areas previously described to consist of necrotic, pale tissue in their central portions. The blood vessels contain no blood. Surrounding these areas of necrosis the blood vessels are congested. There is some infiltration of leucocytes and at the tip of the area toward the pelvis are to be found in one or two instances thrombi in the arteries which contain streptococci. No other bacteria are found. There are no bacteria found in the majority of the infarcted areas. In one, however, in which the process has gone on to suppuration the central

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Fig. 27. Microphotograph of one of the dilated tubules filled with pus and desquamated epithelial cells. Note that the tubule is definitely the center of bacterial activity and pus production. A few bacilli are seen breaking through the tubule into neighboring tissue. They are unattended by pathological change. Bacilli treated with formalin. Photo by L. S. Brown x 1,500.

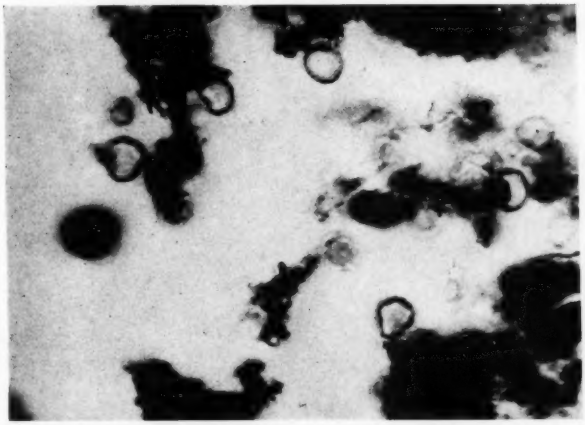

Fig. 28. Same case as shown in Figs. 26 and 27. Colon bacilli in the blood stream of the kidney. Photo by L. S. Brown x 1,500.

portion of the pyramidal area is filled with leucocytes and necrotic renal cells and contains a large number of streptococci, some in long chains.

Case 28. *Autopsy* No. 3520. West Medical 1012-1. Male, 40, November 18, 1915.

Admission Diagnosis. Cardiac decompensation, bronchopneumonia. No previous urinary symptoms.

Present Illness. Sudden chill and weakness five weeks ago, since which time he has shown temperature with symptoms of cardiac decompensation.

Urine examination not recorded.

Patient died third day.

Clinical Diagnosis. Cardiac decompensation, bronchopneumonia.

Autopsy. 25½ hours post mortem. *Anatomical Diagnosis*: Chronic adhesive pericarditis. Mediastinitis. Pleuritis. Hypertrophy and dilatation of the heart. Chronic passive congestion. Pneumonia of the inferior lobe of right lung. Infarcts of left kidney.

Kidneys. Right weighs 140 grams. Capsule strips easily. The markings are retained and the cortex is not narrowed. The pelvis and ureter are negative. Left kidney weighs 170 grams, capsule strips leaving a smooth surface which shows in two places small yellowish areas, which on section are seen to be the basal surfaces of small pyramidal masses extending into the tissue for a short distance and are marked off from the rest of the kidney substance by narrow pale red margins. The largest infarct measures 5 mm. at the base. The markings are retained and the cortex is not narrowed. The pelvis and ureter are negative; the bladder and prostate are negative.

Microscopic Examination. The kidney shows acute degenerative changes in the epithelium, in each of two sections a small infarcted area.

Bacteriological Report. Cultures from the spleen show no growth.

Sections Stained for Bacteria. In the cortical region is situated a small pyramidal area with the base at the periphery and the tip extending down into the cortical substance to a point between the bases of the two pyramids. The center of this area shows homogeneous, acutely degenerated kidney substance without cell infiltration. In the region of the capsule the blood vessels are tremendously engorged with some polymorphonuclear infiltration. This area of engorgement forms a border about one millimeter in thickness over the surface of the infarct. At the tip of the infarcted area two small arteries are found plugged with thrombi containing a few organisms of the pneumococcus streptococcus group (Fig. 20). The periphery of the infarcted area consists of engorged blood vessels with rupture of some of these vessels and liberation of red cells into the tissue and a moderate infiltration with polynuclear leucocytes. No bacteria are found in any portion of normal kidney tissue or infarcted area except within the two arteries plugged with thrombi already mentioned.

The lesions above described are shown in these cases as follows: Perinephritic abscess was demonstrated in cases 4 and 9, capsular abscess and capsulitis appear in cases 4 and 9, cortical abscesses appear in cases 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, and 27. Septic infarct was demonstrated in cases 10, 13, 21, 27, and 28, while diffuse suppuration appears in cases 4, 7, 21 and 26.

The Lesions Produced by the Colon-Typhoid Group of Bacteria. The lesions characteristic of this group of organisms are acute pyelitis, acute pyelonephritis, chronic pyelonephritis and pyonephrosis. As evidence of this we submit cases 29 to 33.

Case 29. *Autopsy* No. 3503. Children's Medical vol. 33, p. 75. Female, 4 months. September 16, 1915.

P. I. For one week before entrance child began to look sick but continued to eat well; for past two days has been feverish.

Physical Examination. Negative. Since entering the hospital temperature has continued irregular and high, varying from 100° to 103°, with a premortal rise to 107°. Child unable to take food except in one ounce amounts. Continued to lose strength and died 13th day.

Urine at entrance showed small trace of albumin, many pus cells and at four subsequent examinations findings continued the same.

Examination of stool, negative. *Culture of urine,* b. coli.

Clinical Diagnosis. Pyelonephritis. Toxic absorption. Heat prostration.

Autopsy. 22½ hours post mortem. *Anatomical Diagnosis:* Bronchitis. Emaciation. Fatty metamorphosis of the liver. Slight defective closure foramen ovale.

Kidneys. Combined weight 26 grams. Capsules stripped leaving pale, smooth surface. On section the tissue is of good consistence. Markings are made out and cortex measures 2 mm. In the pelvis of one kidney there are three or four minute yellowish fine concretions. Pelves otherwise negative.

Bacteriological Report. Culture from the heart at autopsy shows no growth.

Microscopical sections of the kidney show some acute degeneration of the tubules, no glomeruli change (Fig. 21).

Sections Stained for Bacteria show slight thickening and polynuclear infiltration of the mucosa of the papillæ and calices throughout the section with large numbers of bacilli scattered throughout the mucosa among the cells (Fig. 22). The glomeruli, tubules and interstitial tissue show no bacteria. There are no bacteria in the blood vessels or lymphatics. In one portion of the section, a portion of a pyramid lying in contact with a recess of a calyx shows over an area extending 2-3 mm. into the tissue, a few isolated bacilli unattended by

pathological change lying in the lymphatics of the interstitial tissue.

Case 30. Female, 15, private patient of Dr. Hugh Cabot, January 15, 1915.

Diagnosis. Left pyonephrosis.

P. H. Since infancy has had more or less pyuria, the amount of pus in the urine having decreased considerably during the last four years. During the past five or six years has had prolonged course of treatment with autogenous vaccines. The urine has always contained large amounts of pus, albumin and microorganisms which have been variously classified as b. coli and proteus by different observers.

Cystoscopy shows some diffuse redness of the bladder. Right ureteral orifice normal. Urine from the right ureter clear and clean. The left ureteral orifice is edematous and the urine from the left ureter is very dilute, slightly turbid, and flows freely. Phenolsulphonephthalein functional test, intramuscular injection, right kidney—appearance time, six minutes, amount in one hour 20%; left, 15 minutes, one hour amount 3½%. The capacity of the left pelvis is 50 c.c. plus. Injected radiograph shows very large dilated pelvis and ureter with widely dilated calices. *Right urine* shows only a few red blood cells (traumatic); stained sediment shows no bacteria. *Left urine* shows albumin, very slight trace; sediment much pus, many irregular-sized motile bacilli, considerable renal epithelium. Stained sediment shows one type of organism present, a Gram-negative bacillus. Cultures right urine no growth; left urine shows a profuse growth of a Gram-negative bacillus, cultural characteristics and agglutination test classifying it as b. coli communior.

Operation. Left nephrectomy with removal of ureter to the brim of the pelvis. Rapid and uneventful convalescence.

Pathological Report. The specimen consists of a kidney and fragment of ureter 12 cm. long. The kidney is slightly enlarged. The circumference of the ureter varies from 3 to 4

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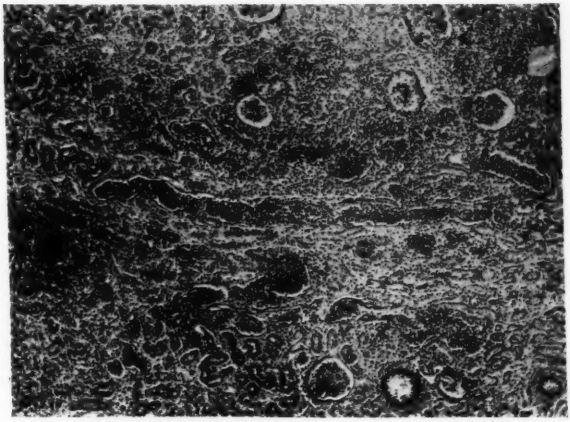

Fig. 29. Microphotograph of another typical pyelonephritis similar to that shown in Figs. 26, 27 and 28, save that in this case there was no previous cystitis, bladder instrumentation or condition of bladder or ureter damage. An ascending infection was clearly impossible in this case. Photo by L. S. Brown x 45.

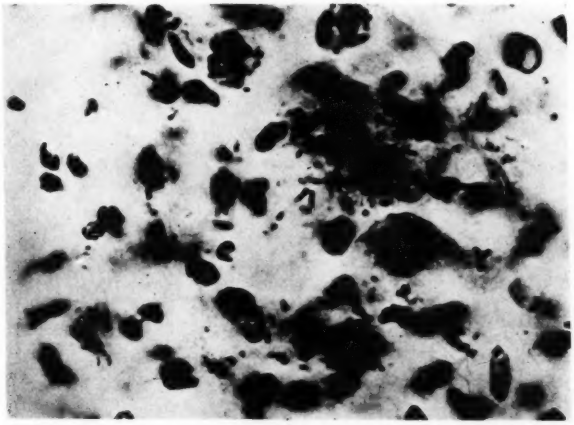

Fig. 30. Destruction of tubule by colon bacilli. Same case as Fig. 29. Photo by L. S. Brown x 1,500.

cm. The split kidney shows extensively dilated calyces with very little kidney substance remaining. The kidney cortex measures from 1 to 4 mm. in thickness. The kidney tissue remaining is rather pale, markings can be made out and the capsule strips easily save in a few places. The pelvic mucosa is markedly thickened and has a finely granular non-reflecting surface. The ureter shows the same thickening of mucosa as the pelvis. The infiltrative process in many places extends through the muscularis and is marked about the blood vessels.

Microscopic Examination shows a somewhat thickened capsule. The glomeruli for the most part are undamaged. In other areas a few show a smooth hyaline appearance. There is some round cell infiltration of the interstitial tissue generally distributed over the section. A portion of the convoluted tubules show hyaline degeneration (Fig. 23). In a few of these the epithelium is desquamated and is found in the lumina of the tubules lower down. The lumina of the tubules are generally dilated, particularly in the pyramids, in which area there is also considerable interstitial thickening. The mucosa of the pelvis is much thickened and infiltrated with pus cells (Fig. 24). Just beneath the pelvic mucosa is infiltration with round cells and a few polynuclear leucocytes extending into the pyramids for a distance of ½ cm. Sections of the ureter wall show some infiltration of the muscularis with some areas of polynuclear cells in the periureteral tissue. The mucous membrane is much thickened and infiltrated with pus cells. The submucosa shows dense lymphocytic infiltration (Fig. 25) with a few pus cells.

Sections Stained for Bacteria show no bacteria throughout the greater portion of the kidney. The area of submucosa infiltration in the pelvis, tips of pyramids and the ureter show a few scattered bacilli. The pelvic and ureteral mucosa and masses of débris within the pelvis and ureter show large numbers of colon bacilli. The groups of desquamated epithelial and pus cells previously described in the lumina of the con-

voluted tubules show no bacilli. In some few areas single bacilli were found in the lymphatics of the interstitial tissue of the pyramids.

Case 31. *Autopsy* No. 2035. West Medical 678-101. Female, 18. September 21, 1907.

Present Illness. Since childhood has had a complex group of symptoms, but none of a urinary nature, chiefly of gastric disturbance. The diagnosis of hysteria and gastric neuritis has been frequently made at several Boston hospitals.

Temperature at entrance normal.

Urine, negative. *White blood* count 6,500.

Patient remained in the hospital for 26 days, when she developed a temperature, symptoms of bronchopneumonia and died ten days later.

Urine examination one week before death showed acid reaction, very slight trace of albumin, moderate number of pus cells without casts.

Clinical Diagnosis. Hysteria, bronchopneumonia.

Autopsy. 7½ hours post mortem. *Anatomical Diagnosis*: Extensive bronchopneumonia. Suppurative nephritis. Acute degeneration of the myocardium. Soft spleen. Fatty liver.

Kidneys. Combined weight 245 grams. In one kidney there are numerous large and small dark red blotches in the cortex. On section these blotches correspond to red bands and streaks of varying width extending from the cortex into the pyramids. The pelves are not dilated; the ureters are negative.

Microscopic Examination of the kidneys shows suppuration.

Bacteriological Report. Cultures from the heart blood show a few colonies of bacilli.

Sections Stained for Bacteria show an extensive suppurative nephritis of the pyelonephritis type. Bacilli are found only in the convoluted and collecting tubules and the pelvis. There are no cocci.

Case 32. *Autopsy* No. 858. South Surgical vol. 61, p. 65. Male, 56. March 21, 1902.

Diagnosis. Cancer of stomach and liver.

P. H. Negative as regards kidney symptoms. For two years loss of weight and strength associated with severe gastric symptoms. Physical examination shows tumor mass in epigastrium. Negative kidney examination, and negative urine although no sediment was done.

Operation. Exploratory laparotomy for adeno-carcinoma of stomach and secondary carcinoma of liver with drainage of wound.

Patient had to be catheterized permanently from operation until death.

Temperature remained subnormal throughout illness. Patient extremely weak and losing ground constantly. Wound showed a constant discharge of chylous fluid with some suppuration.

Patient died quietly on the twenty-second day.

Autopsy. 15 hours post mortem. *Anatomical Diagnosis*: Adeno-carcinoma of pancreas with metastases in the mesentery, lesser and greater omentum, walls of the intestine, stomach, peritoneum, liver and the left adrenal. Ascites. Fibrinous peritonitis. Chronic adhesive pericarditis. Arteriosclerosis of vessels of Willis. Suppurative nephritis. Slight dilatation of the pelvis of the right kidney. Slight chronic interstitial nephritis right kidney. Laparotomy wound. Healed fracture left humerus.

Kidneys. Combined weight 260 grams. *Left kidney*—Capsule strips leaving a smooth surface mottled in places with pinhead-sized yellowish areas distinct and in small groups. In one place these areas show red mottling. On section they extend over a short distance into the cortical tubules. The markings are retained. The tissue of the upper portion of the pyramids and cortex shows some red marking and pinhead-sized yellow and red areas. Pelvis and ureter not ab-

normal. *Right kidney*—Capsule strips leaving a smooth surface. On section the kidney tissue is firm, the markings retained and the section surface generally is flint-colored. There is some slight dilatation of the ureter and pelvis. On section the mucosa of the ureter is not remarkable and entrance of ureter into bladder is free. The portion of the ureter which runs through the bladder wall is the smallest in caliber. Bladder not remarkable.

Microscopic Examination. The sections show abscesses in the small cortical tubules (Fig. 26). There is cloudy swelling of many of the convoluted tubules. There is also some arteriosclerosis. In other portions of the kidneys there is increase in the interstitial connective tissue with atrophy of many of the convoluted tubules and fibrous thickening of some of the glomerular capsules.

Bacteriological Report. Cultures from heart blood—no growth. Cultures from liver—bacilli of the colon group. Cultures from the spleen—a few colonies of streptococci.

Sections Stained for Bacteria. The picture is typical of a pyelonephritis (Fig. 26). Glomeruli are normal throughout the section save where they are secondarily invaded by suppurative processes within the neighboring tubules and are even then free from bacteria. Everywhere the tubules are dilated and filled with pus and desquamated epithelial cells. There is considerable lymphocytic and moderate pus cell infiltration of the interstitial tissue. Bacteria are rarely seen in the interstitial tissues. Large numbers of Gram-negative bacilli are found among the pus cells of the dilated tubules (Fig. 27). As a rule, no bacilli are to be found in glomeruli. In a few of the larger veins and arteries an occasional bacillus is seen (Fig. 28). In some of the tubules masses of bacilli are to be found apparently occupying what was once the lumen of a tubule. In some instances in what appears to be an abscess are to be seen the remnants of three or four tubules filled with bacilli, serving as the centers of infection for the

confluent mass which has resulted in small abscess formation. There are no cocci.

Case 33. *Autopsy* No. 510. South Surgical vol. 34, p. 94, 252,249. Female, 56. November 5, 1899. *Diagnosis.* Fibroma of uterus.

P. H. Entirely negative as regards kidney symptoms. Entire complaint is vaginal discharge and hemorrhage.

Physical Examination negative save for the presence of a large fibroma of the uterus.

Operation. Complete hysterectomy with drainage.

Patient in extremely poor condition from shock at the end of operation. After operation patient continued to run a swinging temperature varying from 100° to 102.8°. Developed tenderness in both costovertebral angles. Gradually failed and died on 14th day.

Urine specimen reported on day of death was said to have shown no albumin, sediment was not done.

Autopsy. 29½ hours post mortem. *Anatomical Diagnosis*: Hysterectomy. Circumscribed peritonitis, with purulent infiltration and necrosis of tissues of the abdominal wall near wound. Multiple old infarcts of spleen. Chronic mitral endocarditis. Cholelithiasis. Suppurative nephritis.

Kidneys. Capsules strip easily and leave a granular surface thickly dotted over with gray opaque mottling. On section cortex is increased in width 8-9 mm. Cortices present a mottled gray opaque appearance from the presence of numerous discrete and confluent pinhead-sized opaque areas. Pyramids show gray lines. The mucosa of the pelvis shows reddening and ecchymotic areas. Bladder reddened.

Bacteriological Report. Cultures from heart, liver, spleen and kidneys show colonies of a bacillus which was not classified but seemed from its growth on agar to belong to the colon group.

Microscopic Examination of the kidney shows some postmortem degeneration, extensive infiltration of polynuclear

leucocytes with disappearance of the renal epithelium over considerable areas of tissue so that abscesses are formed; some dilated tubules filled with polynuclear leucocytes and epithelial cells (Fig. 29).

Sections Stained for Bacteria. The picture is typical of a pyelonephritis (Fig. 29). Glomeruli are as a rule free from bacteria and also free from pus save where invaded from neighboring tubule processes. The interstitial tissue shows considerable lymphocytic and some pus cell infiltration. Throughout the section the tubules are dilated and filled with clumps of bacteria, pus and desquamated epithelium. Few bacteria are found outside the tubules. Where bacteria are found outside the lumina of tubules, the renal epithelium is usually extensively destroyed with evidences of liberation of the contained bacteria (see Fig. 30). Where definite abscess formation appears, close observation shows the centers of suppuration to be remnants of tubules which have been extensively destroyed. The appearance of true abscess is due to confluence of the destructive processes in several neighboring tubules. There are no cocci seen in the section. Large numbers of Gram-negative bacilli, mostly in tubules, are clearly the etiological factor in the process.

Note

The striking similarity between the findings in this case and the preceding, No. 32, is of interest because in the former the conditions for an ascending infection exist, while in this case by no stretch of the imagination can the bladder be considered the origin of the renal condition. One might be an ascending infection, the other clearly cannot be, yet the pathological pictures presented are indistinguishable.

In this group of cases acute pyelitis and also chronic pyelitis are shown in cases 29, 30, 31, 32 and 33. Acute pyelonephritis

does not appear and its incidence is inferential, as we shall later show. Chronic pyelonephritis is shown in case 30, as is pyonephrosis.

Infection of the Kidney With Both Non-Pyogenic and Pyogenic Organisms Will Produce a Mixture of the Lesions Characteristic of Both Groups. This fact we believe explains the not uncommon fallacy that the colon bacillus will produce abscess of the kidney. This has been freely stated and appears to have been supported by the evidence of cultures obtained from the kidney. This reasoning we have shown to be fallacious for two reasons. First, cultures containing both colon bacilli and cocci will frequently be interpreted as showing only colon bacilli, since this organism grows with great rapidity and readily obscures the colonies of cocci. Second, it has been assumed that the cultures obtained from one part of a kidney represented the lesions produced in the whole kidney. This we have shown to be fallacious by the actual demonstration of bacilli in one portion of the kidney, cocci in another, and cocci and bacilli associated together in still other portions (Fig. 31). Our experience has led us to believe that in these mixed infections the colon bacillus probably precedes the coccus in point of time. Only in this way can be explained the appearances in certain kidneys which will be below described. These mixed lesions are rather likely to be found in cases occurring in Group II of our classification, that is to say, kidneys handicapped by previous disease. In support of these propositions we submit cases 34 to 56 showing mixed infection with cocci and bacilli, cases 57 and 58 showing infection with two different kinds of cocci, and cases 59 and 60 showing infection with two different kinds of bacilli.

Case 34. *Autopsy* No. 841. West Medical 564-88. Female, 51. March 1, 1902.

Present Illness. Six days ago became dizzy (uremia?), fell and had a severe convulsion followed by mental aberrations.

Urine. Acid, 1007, albumin ½%, very small amount of pus and casts.

Temperature averaged about 100°. *White blood count* 28,000, which later rose to 45,000. Patient gradually lost strength, became more irrational, and finally comatose. Temperature became subnormal and death occurred sixth day.

Clinical Diagnosis. Chronic nephritis.

Autopsy. 18 hours post mortem. *Anatomical Diagnosis*: Chronic interstitial nephritis. Suppurative nephritis. Congenital malformation of the kidneys and anomaly of the right ureter. Bronchiectasis with concretion. Edema of the lungs. Hydrosalpinx.

Kidneys. Small and of unequal size; weight of left kidney 13 grams, right kidney weighs 51 grams. Left kidney shows fetal lobulations and deformity. Capsule adherent. The markings are scarcely recognizable. In two areas are small cysts. Abnormal arrangement of the renal arteries. Right kidney is also deformed, its pelvis being nearer one pole than usual. Capsule adherent. The distinction between cortex and pyramids is obscured. The markings of the cortex are absent. At one point in the renal tissue is a cavity 6 mm. in diameter full of pus. Ureter is of normal caliber until near the bladder, when it becomes dilated. Its orifice in the bladder not found but in the situation of its orifice is a swollen area which on section exudes thin purulent fluid. A fibrous cord connects the pelvis with the lower portion of the ureter to which it is joined a few millimeters from the bladder. It has no lumen.

Bacteriological Report. Liver and spleen show bacillus coli communis.

Sections Stained for Bacteria. Many staphylococci are found in plugs in a few of the tubules, a considerable number of Gram-negative bacilli are found in the pelvis of the kidney. There are no abscesses in the sections preserved.

Case 35. *Autopsy* No. 1076. West Surgical 403-163. Male,

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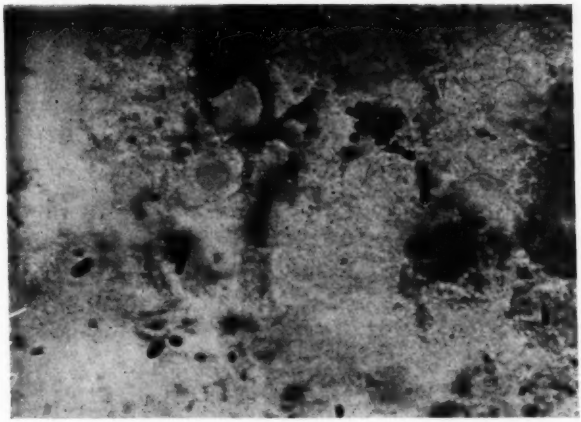

Fig. 31. Mixed colon bacillus and staphylococcus infection in a kidney removed at operation. Cultures taken at operation were reported B. Coli alone. Pathological examination showed multiple abscess formation. Error in diagnosis of the nature of the infection from dependence upon culture was due to overgrowth of staphylococci by the colon bacillus. Photo by L. S. Brown x 1,500.

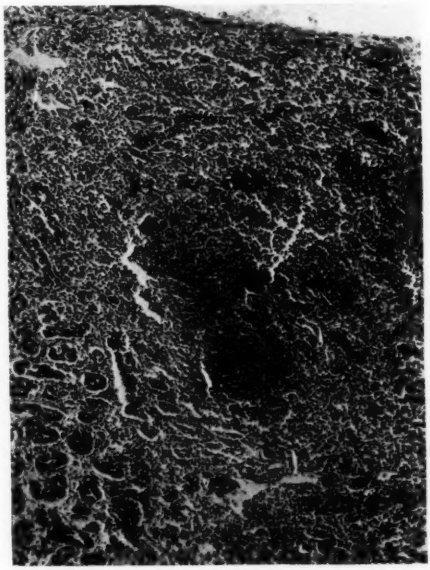

Fig. 32. Microphotograph of true abscess due to bacilli. One of the organisms is the colon bacillus, the other a Gram-positive organism. Photo by L. S. Brown x 70.

40. June 24, 1902. Patient brought to Accident Room unconscious with fracture of cervical vertebra.

Urine examination on admission negative. Six months later slight trace of albumin, hyaline casts, much pus. Patient has been catheterized since injury. Irregular temperature with occasional chills for past four months. Death from exhaustion and sepsis on three hundred and twentieth day.

Clinical Diagnosis. Cervical fracture.

Autopsy. 6½ hours post mortem. *Anatomical Diagnosis*: Calculus pyelitis and ureteritis with suppurative nephritis of the right kidney. Obstructing stone in ureter. Cystitis. Infarct right lung. Scar of old fracture of cervical vertebra.

Kidneys. Combined weight 440 grams. Capsules strip easily, leaving a smooth surface showing some red mottling. Left kidney shows fairly firm tissue without narrowing of the cortex. In places the section surface is mottled with red areas. The right kidney tissue is somewhat soft, section surface generally pale with retained markings. The cortex is slightly narrow. In many places and especially in the cortex are numerous small red areas. The pelvis of the right kidney is dilated; its mucosa is grayish red and bathed in dirty, yellowish, purulent material. The calyces are dilated and contain small yellowish concretions. The upper portion of the ureter for a distance of 2 cm. is dilated, its mucosa roughened and grayish to red in color. Its lumen is occluded by a small stone. Below this situation the ureter is normal in size. Its mucosa is smooth, showing here and there a few small ecchymoses. The left ureter is normal. Bladder shows dirty, yellowish, foul fluid and its mucosa presents numerous red patches.

Microscopic Examination. Right kidney shows extensive infiltration with round cells, in places also infiltration with leucocytes. The left kidney shows renal tissue to be infiltrated, in areas, with pus cells, and the normal kidney structure is disintegrated at these points.

Bacteriological Report. Cultures from the heart, liver and spleen show liquifying scum of growth of bacteria.

Sections Stained for Bacteria. A considerable variety of bacteria, some of which are staphylococci, are found scattered throughout purulent areas in the kidney. Many bacilli.

Case 36. *Specimen number* 92-61. South Surgical 176-211. Male, 53. February 19, 1909.

Present Illness. For two months has had carbuncle on the back of the neck. For one month has had nausea, some vomiting and intestinal disturbance, chiefly diarrhea.

Operation—Appendectomy. Chronic appendix found and removed. Following operation a patch of dulness located in left lower back.

Cystoscopy showed small amount of pus from the right ureter; *X-ray* negative. Culture from the bladder urine showed colon bacilli with a few colonies of staphylococci. Cultures from the appendix wound which had become septic showed staphylococcus aureus and colon bacilli. Diagnosis of acute hematogenous kidney made and operation determined upon. Small perinephritic abscess found, cultures from which showed staphylococcus aureus. The kidney was found generously sprinkled with small abscesses. Nephrectomy done.

Pathological Report. Kidney considerably enlarged, weight 200 grams. Capsules thickened. There is a large abscess at one pole of the kidney, and numerous small abscesses scattered throughout the remainder of the kidney cortex. These are filled with thick, tenacious pus showing small micrococci in clumps.

Microscopic Examination showed multiple abscesses. Diffuse round cell infiltration of the remaining tissue with obliteration of the tubules and glomeruli.

Pathological Diagnosis. Focal suppurative nephritis.

Sections Stained for Bacteria. A large number of staphylococci and a moderate number of Gram-negative bacilli are

found in the small abscess cavities and some of the tubules and occasionally in the lymph spaces of the interstitial tissue.

Case 37. *Autopsy* No. 859. South Surgical LX-258. Male, 56. March 6, 1902.

Past History. Gonorrhea 36 years ago; stricture developed six years later. Has frequently had retention.

Present Illness. Inability to pass water.

Urine. Small trace of albumin, large amount of pus.

Operation. Internal and external urethrotomy for multiple stricture. Patient had uneventful convalescence for 19 days at which time he had a sudden rise of temperature to 103°, nervousness and some vomiting. A few days later patient developed diarrhea. He died on the 33d day.

Clinical Diagnosis. Multiple strictures of urethra.

Autopsy. 19 hours post mortem. *Anatomical Diagnosis*: Chronic cystitis with extension through the bladder wall and through the perivesical tissue. Dilatation of the ureters. Double hydronephrosis. Ureteritis. Pyelitis. Suppurative nephritis. Suppurative focal pneumonia. Atheromatous endocarditis of the aortic valve. Healed perineal wound for stricture of urethra. Stricture of urethra at the peno-scrotal angle.

Kidneys. In each renal pelvis opaque purulent fluid. Kidneys are unequal in size; weight not given. Capsules slightly adherent. At various points on the free surfaces are yellow slightly elevated areas which on section contain milky white pus. The kidney tissue covering the more dilated portion of the pelvis shows atrophy and the markings are obscured. The cortex is diminished in width.

Microscopic Examination. Kidneys show increase in the interstitial connective tissue, atrophy of the tubules, infiltration with small round cells; some fibroid atrophy of the glomeruli. Some of the tubules show many pus cells.

Bacteriological Report. Fluid expressed from the kidney shows a number of bacteria, many of them Gram-negative ba-

cilli, staphylococci and streptococci. Cultures from the heart, no growth; liver and spleen—bacillus coli communis; kidney—many variations of bacteria.

Sections Stained for Bacteria show staphylococci in the tubules, colon-like bacilli in the blood stream and staphylococci and bacilli in the pelvis.

Case 38. *Autopsy* No. 1817. West Surgical 545-107. Male, 79. October 1, 1906.

Past History. For past 15 years has led catheter life on account of enlarged prostate.

Present Illness. Four days ago broke his catheter, leaving four inches in his bladder. Temperature normal on admission.

Urine. Alkaline, slight trace of albumin; sediment pus and blood cells.

Operation. Perineal section for foreign body followed by partial suprapubic prostatectomy. Patient died as immediate result of this second operation on forty-sixth day after admission.

Clinical Diagnosis. Enlarged prostate and senility.

Autopsy. 6 hours post mortem. *Anatomical Diagnosis*: Diphtheria. Cystitis, ureteritis and pyelitis. Suppurative nephritis right. Operation wound, prostatectomy. Arteriosclerosis. Fibro-calcareous endocarditis. Focal tuberculosis of liver.

Kidneys. Combined weight 240 grams. Capsule of left kidney strips, leaving a firm smooth surface. Capsule of right kidney strips, leaving a firm smooth surface showing here and there small abscesses. The pyramids in places show fine grayish-yellow streaks. The mucosa of the pelvis is covered with a grayish-yellow necrotic membrane. This material extends along the mucosa of the ureter over its entire length. The ureter is moderately dilated. The mucosa of the bladder is covered with exudate and contains foul urine. The walls of the bladder are thickened and in several places there are small

diverticula. In the situation of the prostate there is a grayish, ragged, necrotic cavity.

Microscopic Examination. No description of the kidney tissue is recorded.

Bacteriological Report. Cultures from the heart blood yield no growth; from the spleen profuse growth of bacilli.

Sections Stained for Bacteria. No blocks of kidney tissue were preserved. Sections from the prostate and liver show many staphylococci and a few bacilli. The prostate shows some glandular elements filled with pus in which the bacteria are located. The bacteria in the liver are found in the central veins.

Case 39. *Autopsy* No. 2220. West Surgical 609-53. Female, 40. September 22, 1908.

Present Illness. For one year definite symptoms of gallstones.

Temperature, normal. *Urine,* negative.

Operation. Choledochostomy, cholecystectomy. Moderate sepsis of wound, moderate temperature. Seventh day after operation patient became drowsy, urine considerably decreased in amount, bloody, small trace of albumin, some pus, considerable number of cellular casts. Patient died 18th day.

Clinical Diagnosis. Cholelithiasis, pyonephrosis.

Autopsy. 6 1/3 hours post mortem. *Anatomical Diagnosis:* Cystitis. Ureteritis. Pyelitis. Suppurative nephritis. Arteriosclerosis. Slight fibrous endocarditis of the aortic and mitral valves. Ulceration of the intestines. Chronic peritonitis. Operation wound, cholecystectomy and choledochostomy.

Kidneys. Combined weight 310 grams; capsules strip. Surfaces are mottled with many small discrete and confluent yellowish areas which bulge in some places. Section surfaces are mottled with dirty, yellowish areas which extend well down into the pyramids. The mucosa of the pelvis shows many minute ecchymoses and small areas of fibrin. The ureters are

free and contain pus. The mucosa of the ureters shows ecchymoses; bladder the same.

Microscopic Examination. Kidneys show many abscesses and extensive leucocytic infiltration.

Bacteriological Report. Cultures from the heart blood and spleen show no growth, from the kidney bacilli.

Sections Stained for Bacteria show mixed staphylococcus and Gram-negative bacillus abscesses of the cortex.

Case 41. *Autopsy* No. 2221. West Medical 710-33. Male, 25. October 6, 1908.

Present Illness. Three weeks of pain in the right kidney region with fever, and for four days severe vomiting. *Temperature,* 102-105. *Urine.* Acid, slightest possible trace albumin, rare cast with pus cells adherent, considerable pus. *White blood count,* 25,600. Guinea pig inoculated promptly died. Death too early for evidence of tuberculosis. Patient died fourth day.

Clinical Diagnosis. Hematogenous kidney.

Autopsy. 13¼ hours post mortem. *Anatomical Diagnosis:* Septic infarcts and multiple abscesses of right kidney. Thrombosis right renal vein. Acute localized peritonitis of the right side of the abdomen. Septic infarcts and multiple abscesses of lungs. Soft spleen. Staphylococcus pyogenes aureus septicemia.

Kidneys. Left kidney weighs 171 grams, tissue is somewhat soft, kidney not otherwise remarkable. The right kidney is enlarged. The cortex is mottled with minute yellow areas from some of which pus oozes when the capsule is removed. On section the markings are lost. Here and there are dark red areas in some of which the central portions show abscesses. The mucosa of the pelvis shows ecchymosis. Both ureters are free. The right renal vein is occluded by a large thrombus.

Microscopic Examination of the kidney is not recorded.

Bacteriological Report. Cultures from the heart blood,

spleen and right kidney show profuse growth of staphylococcus pyogenes aureus and a slight growth of bacilli.

Sections Stained for Bacteria show staphylococci in the abscesses apparently in pure growth, staphylococci and bacilli in the pelvis.

Case 41. *Autopsy* No. 832. West Surgical 389-238. Male, 40. November 6, 1902.

Past History. Gonorrhea 7 years ago. Now has evidence of stricture. *Present Illness.* Acute retention. This morning unsuccessful attempt made by his own doctor at catheterization. *Temperature* normal.

Urine. Albumin, trace; sediment, much pus and blood.

Operation. Dilatation of stricture. Three days later chill, fever, vomiting, followed by suppression of urine.

Operation. Right nephrotomy for pyonephrosis. Kidney found to be dilated, apparently recent infection. Operation did not improve patient's condition and he died fifteenth day.

Clinical Diagnosis. Stricture of urethra, pyonephrosis.

Autopsy. 19¼ hours post mortem. *Anatomical Diagnosis*: Malformation of kidneys with extensive suppurative nephritis. Fatty metamorphosis of liver. Hyperplasia of spleen. Hypertrophy and dilatation of heart. Inguinal operation wound.

Kidneys. In the region of the operation wound is an irregular mass of tissue which extends into the abdomen. This is found to consist of kidney tissue and measures about 14 cm. in length. Capsule strips leaving a fairly smooth yellowish brown surface showing in several places yellowish-brown areas which on section contain pus. *Cover glass preparations* from this material show numerous leucocytes and a few bacilli. Two ureters are present. The left ureter leads to the pelvic mass of kidney tissue above described, the right ureter opens into the shell of tissue in the right inguinal region.

Microscopic Examination. In three sections of the kidney

there is considerable post mortem change and much suppurative nephritis.

Sections Stained for Bacteria. In the centers of the suppurative areas are many staphylococci. A section of the liver shows numerous Gram-negative bacilli and staphylococci in the central vein. There are many Gram-negative bacilli in the tubules and some suppurative areas surrounding dilated tubules filled with bacilli and cocci.

Case 42. *Autopsy* No. 827. East Medical 561-138. Male, 53. December 37, 1901.

Present Illness. Symptoms of cerebral embolism of sudden onset. Was put on constant drainage on account of incontinence. Developed urethritis.

Urine Examination. At entrance and all through stay in hospital showed albumin and moderate quantities of pus. Fourteenth day in hospital developed carbuncle. Developed lung symptoms. Culture from carbuncle showed growth of staphylococcus aureus. Died forty-seventh day.

Clinical Diagnosis. Cerebral embolism.

Autopsy. 34¾ hours post mortem. *Anatomical Diagnosis*: Chronic cystitis. Pyelitis. Slight dilatation of renal pelves and ureters. Suppurative nephritis. Arteriosclerosis vessels of Willis. Degeneration of posterior columns and crossed pyramidal tracts of the spinal cord.

Kidneys. Capsules strip, surfaces present here and there many brownish yellow spots and indurations. On section through these indurations yellowish mucopus is obtained. On section kidney shows scattered brownish yellow spots and faint streaks. The pelves of the kidneys show some dilatation with numerous areas of ecchymosis in the walls. Ureters are moderately dilated and filled with thin fluid pus. Ureteral openings are free. Bladder shows areas of ecchymosis and contains a moderate amount of thin pus. Two small abscesses of the prostate.

Cultures of the heart and liver show growth of b. coli communis.

Microscopic Examination. Foci of suppuration and small abscesses are present. In these are many mononuclear and polynuclear leucocytes. There is a considerable increase in interstitial connective tissue but without lesions of the glomeruli characteristic of chronic glomerular nephritis.

Sections Stained for Bacteria. Predominant organism scattered throughout the tissue where there is evidence of suppuration is colon-like bacillus, in some areas cocci are to be seen, and in still others, particularly the cortical abscesses, the majority of bacteria are staphylococci.

Case 43. *Autopsy* No. 522. South Surgical XL-80. Male, 63. September 23, 1899.

Present Illness. For three months has had bladder irritability, nausea, vomiting and hematuria; has been catheterizing himself since onset of symptoms. Patient entered hospital with symptoms of uremia.

Urine. Acid, albumin ⅛%, sediment, pus and blood. Died day of entrance.

Clinical Diagnosis. Enlarged prostate.

Autopsy. 13 hours post mortem. *Anatomical Diagnosis:* Adeno-carcinoma of the bladder involving both ureteral orifices. Cystitis. Double hydronephrosis with dilatation left ureter. Acute pyelitis right kidney. Abscesses of both kidneys. Chronic interstitial nephritis. Hypertrophy of heart.

Kidneys. Capsules strip easily. Here and there in both kidneys are small pinhead-sized abscesses.

Microscopic Examination. Sections of the kidneys show marked increase of interstitial tissue with some infiltration with round cells. Tubules of the cortex are greatly diminished in number. Some of those that are present are atrophied and contain hyaline casts. In one section there is moderate infiltration with polymorphonuclear leucocytes.

Cultures from the heart and spleen—no growth. *Cultures* from the kidney—bacillus coli communis.

Sections Stained for Bacteria. Small abscesses previously described show many staphylococci. A few staphylococci are also found in tubules. Many Gram-negative bacilli are found in the pelvis of the kidney in one section. Gram-negative bacilli and cocci are found in the other two sections, one of which contains an abscess.

Case 44. *Autopsy* No. 304. East Surgical 340-83. Female, 58. August 1, 1898.

Present Illness. For six weeks loss of appetite and vomiting, frequent micturition. For one week pain in the angle of the right jaw. Examination shows alveolar abscess; *white blood count* 8,880.

Urine. Acid, albumin slight trace, sugar; sediment, considerable pus. Transferred to Surgical Service.

Operation. Alveolar abscess drained. Death of the patient from general septicemia.

Clinical Diagnosis. General septicemia, alveolar abscess, diabetes.

Autopsy. 14 hours post mortem. *Anatomical Diagnosis*: Abscesses of kidneys. Bronchopneumonia with abscess of the lung. Arteriosclerosis. Wound of neck. General infection, staphylococcus pyogenes aureus.

Kidneys. Enlarged; total weight 462 grams. Capsules adherent. On section several dark red areas are seen scattered through the kidney tissue, some extending from the cortex well into the pyramids. These areas show softening and many of them have yellowish-white areas within them which yield pus. Markings retained. In one area there is a firm yellowish pyramidal area fibrous in character situated between the cortex and pyramid. Pelvic mucosa slightly injected; bladder shows nothing remarkable.

Bacteriological Report. Abscess of neck; heart, spleen, liver and kidneys show profuse growth of staphylococcus pyogenes

aureus. *Cover glass preparation* of pus from kidney abscess shows staphylococci, and numerous large irregularly stained bacilli.

Microscopic Examination. Kidney abscesses show staphylococci, in many cases phagocyted.

Sections Stained for Bacteria. Many abscesses are found situated in the cortex. Small abscesses originating in the tubules, sometimes in the convoluted portion, at other times in the ascending and descending loops, are to be found. These small secondary abscesses uniformly underlie the apparently primary larger abscess near the cortex. The abscesses frequently show large clumps of bacteria, which may be seen macroscopically, lying within the necrotic area. In most instances cocci alone are to be found, in others bacilli alone, while in still others the process is mixed. Bacilli and cocci are occasionally found in clumps arrested low down in the collecting tubules. There are both bacilli and cocci in the pelvis of the kidney.

Case 45. *Autopsy* No. 301. East Surgical 338-166. Male, 65. July 11, 1898.

Past History. Frequent micturition with slowing of stream for six years. Operation for stricture one year ago.

Present Illness. Recurrence of same symptoms.

Physical Examination shows filiform stricture of bulb.

Operation. Divulsion of stricture.

Urine. At entrance alkaline, albumin 1/10%, much pus, few red blood cells. Sixteen days after operation developed temperature and pain in the right kidney region. Temperature increased, suppression of urine, distension; patient died seventeenth day.

Clinical Diagnosis. Stricture of urethra.

Autopsy. 18 hours post mortem. *Anatomical Diagnosis*: Suppurative nephritis. Pyelitis. Ureteritis. Slight dilatation of renal pelvis and ureter on right side. Hypertrophied bladder with diverticula and cystitis. Arteriosclerosis. Car-

diac hypertrophy. Edema and congestion of lungs. Hemorrhagic infarction of kidney.

Kidneys. Capsules strip leaving smooth surface. On section, tissue mottled red and yellow. In one pole of the left kidney chestnut-sized red cyst. Scattered throughout tissue many pea-sized abscesses. Some of these abscesses continue as dark red areas down into the pyramids. The papillary portion of the pyramids shows yellowish-white streaks. *Cultures* from kidneys show staphylococcus aureus and colon bacilli.

Sections Stained for Bacteria. No abscesses in sections preserved. Gram-negative bacilli, clumps of staphylococci and some bacilli are found in the convoluted tubules.

Case 46. *Autopsy* No. 1164. South Surgical LXXXVII-55. Male, 63. November 5, 1903.

Present Illness. Eight years ago abscess of perineum, now has filiform stricture.

Urine. At entrance acid, trace of albumin; sediment clumps of pus, occasional red blood cell. Patient ran an irregular temperature and died, after operation, on the seventy-third day.

Clinical Diagnosis. Stricture of urethra, cystitis.

Autopsy. Anatomical Diagnosis: Pyonephrosis. Cystitis. Chronic urethritis. Perineal fistula. Dilatation of ureters. Ureteritis. Abscess of left kidney. Chronic interstitial nephritis. Abscess of left epididymis and testicle. Streptococcus septicemia.

Kidneys. Somewhat smaller than normal; capsule adherent. Pelvis, calyces and ureters on the right are markedly dilated and filled with a thick yellow pus. The course of the right ureter is tortuous and at its lower extremity at the bladder orifice forms somewhat of a cul-de-sac. The right pelvis is blackish in color and granular. The walls of the pelvis and ureter are thickened. The pyramids of the right kidney are flattened and the cortex narrowed. The markings are obscured. The left renal pelvis, calyces and ureters are

also dilated. They do not yield pus. At two or three places there are cavities in the substance of the kidney filled with pus. The walls of the kidney, pelvis and ureter are thickened. The bladder mucosa is dirty, blackish in color and rough.

Microscopic Examination. A section from one kidney shows fibroid atrophy of portions of the renal tissue and an abscess.

Bacteriological Report. Cultures from the heart blood show a few streptococci.

Sections Stained for Bacteria show staphylococci and Gram-negative bacilli scattered throughout the kidney sections. It is impossible to differentiate the extent of post mortem invasion.

Case 47. *Surgical Case* No. 9134. South Surgical CLXXII-5. Female, 43. November 21, 1908.

Past History. Negative save for symptoms attributed to the appendix.

Present Illness. For one week patient has had abdominal pain localizing in the right loin, with chills and fever.

Temperature at entrance 102; *white blood count* 15,400.

Urine. Acid, small trace of albumin, considerable pus. Rectal examination shows tenderness high up in the rectum with edema and fluctuating mass.

Operation. Incision and drainage of ischio-rectal abscess.

Second Operation. Appendectomy, and nephrotomy with drainage for hematogenous kidney. Specimen excised for examination.

Pathological Report. Two small pieces removed from surface of the kidney, red, hemorrhagic with red cells and some leucocytes.

Section Stained for Bacteria shows staphylococcus and a large Gram-positive bacillus in abscesses.

Case 48. *Autopsy* No. 2685. South Surgical CCVI-85. Male, 64. September 3, 1910.

Past History. Frequent catheterization for past ten years on account of "bladder inflammation."

Present Illness. Complains of frequency.

Urine. Acid, trace of albumin, leucocytes and many bacteria.

Operation. Exploratory laparotomy for tumor of bladder. Bladder palpated but not opened. Operation wound remained clean. After operation patient failed without apparent cause and died thirteenth day.

Clinical Diagnosis. Multiple diverticula, enlarged prostate, cardiac insufficiency.

Autopsy. 18 hours post mortem. *Anatomical Diagnosis*: Suppurative nephritis. Acute pyelitis. Arteriosclerosis. Degeneration of kidneys. Hypertrophy of prostate. Hypertrophy of bladder wall with diverticula. Operation wound.

Kidneys. Combined weight 210 grams. Capsules strip leaving granular surfaces; the tissue is quite firm. The cortex measures 3-6 mm. Here and there the section surfaces are streaked and mottled with small yellow areas. The pelves and calices are moderately dilated. The mucosa is generally reddened. The walls of the bladder are thickened. A few small diverticula and one large one are present. The prostate is considerably enlarged.

Microscopic Examination. There is extensive infiltration with polynuclear leucocytes, in one or two places abscess formation.

Bacteriological Report. Cultures from the heart blood show no growth.

Sections Stained for Bacteria. Sections from the kidney tissue which were preserved show but little suppurative process. Staphylococci and bacilli are found, few in number, in the pelvis.

Case 49. *Autopsy* No. 321. South Surgical XXVIII-124. Male, 66. August 12, 1893.

Present Illness. Prostatic symptoms seven years. Catheterized one month ago and apparently infected at that time.

Operation. Prostatectomy.

Urine. Smoky, acid, large amount of pus, some blood, large trace of albumin. Died 28th day.

Clinical Diagnosis. Hypertrophy of prostate, pneumonia.

Autopsy. 12 hours post mortem. *Anatomical Diagnosis*: Suprapubic cystotomy and partial prostatectomy. Abscess of region of Scarpa's triangle with sinus formation. Thrombosis right femoral vein. Abscess of lungs. Acute pyelitis with abscesses of kidney. Ulcerative prostatitis.

Kidneys. In both renal pelves marked induration of mucosa with some patches of exudate. Cortex 5 mm. Tissue slightly pale and in some of the pyramids grayish-yellow streaks in the papilla. In one kidney there are two or three pinhead-sized abscesses. Sections of the small abscess of the kidney show micrococci with cloudy swelling of the epithelium of the cortical tubules.

Sections Stained for Bacteria show staphylococci in abscesses, bacilli in the yellowish streaks in the papilla, lying within the tubules, bacilli and cocci in the pelves.

Case 50. *Autopsy* No. 2939. West Medical 802-215. Female, 47. October 6, 1911.

Present Illness. Two years of abdominal symptoms, one week of diarrhea followed by distension of the abdomen, and abdominal pain with much vomiting.

Temperature at admission, normal. Later a somewhat irregular fever reaching 100°.

Urine at admission, no albumin, rare leucocyte. *White blood count* 8,500.

Clinical Diagnosis. Cancer of the stomach, disseminated abdominal cancer.

Autopsy. 28½ hours post mortem. *Anatomical Diagnosis*: Diffuse carcinoma of the stomach with extensive metastasis including the right kidney. Carcinomatous strictures of the large intestines. Left bronchopneumonia. Chronic endocarditis of the mitral valve with stenosis. Suppurative nephritis.

Hydronephrosis (right) due to constriction of the ureter by neoplasm. Small infarct of lung.

Kidneys. Combined weight 284 grams; right kidney is small. There is much perinephric induration and thickening, marked about the ureter, especially in its upper portion. The pelvis and calices of the right kidney are dilated and contain a cloudy fluid. The surface of the right kidney is fairly smooth with a few ill-defined gray white areas, both discrete and confluent. On section these areas extend for a variable distance into the renal tissue beneath. The markings of the cut surfaces are obscured. The renal cortex is narrowed. The cortex of the left kidney shows numerous small abscesses. The tissue about these, in many instances, is dark red. These areas are seen to extend into the cortical substance in the form of yellowish-gray streaks. The ureter is not dilated. The bladder is negative.

Microscopic Examination. One section from the right kidney shows an area of carcinoma. There are numerous areas of suppurative nephritis.

Bacteriological Report. Cultures from the heart blood show scum of growth of several types of bacilli.

Sections Stained for Bacteria. Abscesses show only cocci; some Gram-negative bacilli are found in the lymphatics and the blood stream. In the pyramidal portion of the kidney large plugs of bacteria, both cocci and bacilli, are found in the tubules.

Case 51. *Autopsy* No. 3352. Genito-Urinary 10-155. Male, 28. April 25, 1914.

Past History. Stricture of urethra for five years; internal urethrotomy three years ago.

Present Illness. For one year has had recurrent pains in right kidney without fever. For two weeks has had increased frequency followed by severe pain in region of right kidney and vomiting. His urine has been much more cloudy than previously.

Urine. Acid, cloudy, large amount of albumin, much pus and a few red blood cells. *White blood count* 19,000.

Cystoscopy showed cloudy urine from the right side with markedly decreased function; left kidney moderate amount of pus, 10% function.

Cultures from both kidney urines showed colon-like bacillus. *X-ray* showed right renal calculus.

Operation. Right kidney full of small calculi, removed by pyelotomy and nephrotomy. Left kidney showed perinephric abscess with many miliary abscesses in cortex. Patient died fourteenth day.

Clinical Diagnosis. Calculus, pyelonephritis right; acute suppurative nephritis left; uremia; and pneumonia.

Autopsy. 13¼ hours post mortem. *Anatomical Diagnosis*: Nephrolithiasis. Diphtheritic pyelitis and pyonephrosis. Perinephritis with abscess formation. Chronic interstitial nephritis (right) with chronic ureteritis. Double nephrotomy with purulent infiltration of perinephric tissue. Tuberculosis of the lungs. Bronchopneumonia. Focal necrosis of the bladder. Absence of left testicle. Scar of old cystotomy. Fatty liver. Streptococcus septicemia.

Kidneys. Combined weight 330 grams. Abscess of perinephric tissue about each kidney. Right kidney shows adherent capsule. Surface is marked with occasional irregular depressions. In the substance of the kidney extending from the convexity to the pelvis is an irregular excavation bounded by ragged necrotic kidney tissue bathed in pus (nephrotomy wound). The pelvis is moderately dilated, its mucosa covered with a dirty white layer. All the calices are dilated and contain irregular granular concretions and pus. The cortex is markedly narrowed. The right ureter is adherent to the surrounding tissue. Its mucosa is smooth. The left kidney has an adherent capsule, on removal of which several cavities filled with yellow pus are exposed. There are numerous pinhead-sized abscesses on the surface. In the substance of the

kidney extending into the pelvis is an irregular cavity bounded by necrotic tissue (nephrotomy wound). The renal pelvis is moderately dilated and filled with pus; two concretions. The mucosa of the pelvis shows an adherent dirty layer. The left ureter is not remarkable. The bladder and prostate are normal.

Microscopic Examination. One section of the kidneys shows suppurative nephritis, another section shows atrophy and round cell infiltration. At the tip of the pyramids in one section is necrosis and purulent infiltration.

Bacteriological Report. Cultures from the heart blood show profuse growth of colon-like bacilli and cocci.

Sections Stained for Bacteria. In the section preserved there were no abscesses and small evidence of suppuration. Many staphylococci and a few Gram-negative bacilli were found in the pelvis.

Case 52. *Surgical Case* No. 8127. East Surgical 596-207. Female, 25. January 9, 1908.

Past History. Painful micturition since childhood.

Present Illness. Four days of right-sided abdominal pain with vomiting, later pain localized in right kidney region, urine became cloudy.

Urine, at admission, alkaline, slight trace of albumin, much pus.

Temperature 103°. *White blood count* 15,600.

Physical Examination showed a mass similar to appendix abscess and thought to be that.

Operation. Exploratory laparotomy and nephrectomy for acute infected kidney. Uneventful recovery.

Cultures. Peritoneal fluid, no growth. Pus from kidney abscess shows few cocci and bacilli.

Clinical Diagnosis. Acute infected kidney.

Pathological Report. Kidney very much enlarged. On the surface multiple small purulent foci; on section the same are seen in the cortex of the kidney, more rarely in the papilla.

Microscopic Examination. Infiltration with round and pus cells and destruction of the tubules especially in small foci.

Sections Stained for Bacteria. No true cortical abscesses found in tissue. The picture is more that of a colon bacillus pyelonephritis with tubules the center of suppuration. Bacteria found in these areas show mixed infection of staphylococci and Gram-negative bacilli, the latter predominating.

Case 53. *Surgical Case* No. 710-117. South Surgical CLIV-1. Female, 34. October 19, 1907.

Present Illness. Eight days ago onset of abdominal pain in region of appendix with fever which quickly subsided leaving soreness in region of kidney.

Physical Examination. Right kidney palpable and tender. *X-ray* negative.

Urine. At entrance, acid, slight trace of albumin, some pus. *White count* 7,300. Guinea pig inoculation negative for tuberculosis.

Operation. Nephrectomy. Kidney slightly enlarged, pale, few areas of discoloration. It was thought to be the cause of the trouble and removed.

Clinical Diagnosis. Colon-pyelonephritis. Recovery.

Pathological Report. Enlarged soft kidney with opaque yellow stripes and dots in the pyramids surrounded by reddened zones.

Microscopic Examination. Foci of round cell infiltration in many places with intense congestion of surrounding vessels. Epithelium of the tubules swollen, desquamated and the lumen filled with hyaline and granular casts.

Culture from the kidney tissue at operation—colon bacillus.

Sections Stained for Bacteria. Considerable number of Gram-negative bacilli in the tubules and pelves with a typical picture of colon pyelonephritis. Here and there in the cortical region are small abscesses with a mixed infection of Gram-negative bacilli and large numbers of staphylococci.

Note. A colon pyelonephritis with superimposed staphylococcus abscess.

Case 54. *Autopsy* No. 2164. West Surgical 595-261. Female, 54. May 28, 1908.

Past History. Marked constipation for four months.

Present Illness. For five days acute abdominal left-sided pain with chills and fever; temperature of 102°-104° with pussy urine. Two days ago acute tender red mass appeared in the left kidney region.

Urine. Acid, very slight trace of albumin, small amount of pus, microscopic blood. *White blood count,* 22,000. Culture from the urine shows colon-like bacilli.

Operation. Nephrotomy for septic kidney. Kidney considerably and symmetrically enlarged, soft and pulpy with scattered small abscesses of the cortex. Pelvis not dilated. Patient died 10 days after admission, 4th day after operation.

Clinical Diagnosis. Septic kidney.

Autopsy. 7¼ hours post mortem. *Anatomical Diagnosis*: Carcinoma of vagina with obstruction and dilatation of left ureter. Left ureteritis, pyelitis and suppurative nephritis. Nephrotomy wound. Streptococcus septicemia.

Kidneys. Right kidney weighs 171 grams. Capsules strip with some difficulty, leaving a granular surface. Cortex measures 6 mm. Markings are fairly distinct. There are no abscesses in the right kidney. Right ureter is not remarkable. Left kidney weighs 208 grams; perinephric fat separated from the kidney and the space is filled with bloody purulent material. On the convexity of the kidney there is an irregular opening 6 cm. in length leading into the pelvis. The walls of this cavity are composed of soft necrotic kidney tissue. At various places in the cortex and extending into the pyramids the kidney tissue is transformed into a soft yellowish-black semi-fluid material. These areas are wedge-shaped with free pus at the surface. Generally they are sharply outlined from the surrounding renal tissue. The surface of the cortex where

not involved in the above-mentioned necrotic area about the wound shows indistinct markings. There are no abscesses of the kidney. The mucosa of the pelvis and ureter is reddened and the lumen contains purulent areas. The lower half of the ureter is dilated, and its lower end is pressed upon by a tumor mass.

Microscopical Examination shows acute degenerative change with suppuration.

Bacteriological Report. Cultures of the heart blood and spleen show streptococcus and colon-like bacillus.

Sections Stained for Bacteria. There are chains of streptococci in small arteries and in the capillaries of the glomeruli. There are a few clumps of streptococci and Gram-negative bacilli in the straight collecting tubules. There are also a few bacilli in the blood stream.

Case 55. *Autopsy* No. 880. West Medical 570-6. Male, 51. May 28, 1902.

Present Illness. Six months' weakness, some nausea, occasional vomiting, restlessness at night, loss of appetite, nocturia three or four times, slight frequency. Has a history of hematuria once within that period.

Physical Examination. Redness and tenderness with some edema of outer and under side of both thighs and buttocks.

Temperature. Normal at entrance. *White cell count* 48,000.

Urine. Bloody, acid, small trace of albumin; sediment, much blood, few cell casts, moderate number of leucocytes. Patient began to run a septic temperature which reached 102°, became unconscious and died fifth day.

Clinical Diagnosis. Erysipelas.

Autopsy. 19¼ hours post mortem. *Anatomical Diagnosis*: Suppurative nephritis with infarcts of the kidney. Subacute glomerulo and chronic interstitial nephritis. Suppurative prostatitis. Sero-purulent peritonitis. Soft spleen. Mural thrombi in the right auricle and the right ventricle. Thrombi in the right common iliac and right femoral veins. Arterio-

sclerosis with small secondary aneurysm of the left coronary artery. Hemorrhagic edema of the inferior lobe of the left lung. Streptococcus infection.

Kidneys. Capsules free. Surfaces show numerous minute yellow points. The glomeruli do not appear to be abnormal. On section, the areas above described are found to extend through the cortex and into the pyramids in some cases as grayish-yellow lines. Bladder and ureters not remarkable. Prostate shows numerous small abscesses.

Microscopic Examination. In many places the interstitial tissue of the kidneys is increased in amount over small areas and there is atrophy of the renal element and round cell infiltration. In a good many tubules pus cells and necrotic desquamated epithelial cells are present. In one section two abscesses are observed. The capillaries of some of the glomeruli contain leucocytes. In a minority of the glomeruli there are vesicular nucleated cells closely packed together which are proliferated epithelium of the glomerular capsules. There is considerable edema of the interstitial tissue.

Bacteriological Report. Cultures from the heart blood, no growth. Cultures from the liver and spleen, profuse growth of bacteria, mostly staphylococcus.

Sections Stained for Bacteria. Staphylococci, among which are some chains of streptococci, are found in the small areas of suppuration. There are also a few bacilli.

Case 56. *Autopsy* No. 1505. East Surgical 522-119. Male, 69. September 19, 1905.

Past History. Gonorrhea 47 years ago. Stricture 16 years later, operation with divulsion of stricture at that time.

Present Illness. Admitted with retention.

Urine. Acid, slight trace of albumin, much pus.

Temperature normal.

Operation. Perineal section. Twenty days after operation developed temperature and symptoms thought to be right pleurisy, patient refused nourishment, began to vomit, had

partial suppression of urine, and died on the forty-sixth day.

Clinical Diagnosis. Stricture of urethra.

Autopsy. 33 hours post mortem. *Anatomical Diagnosis:* Stricture of urethra. Perineal sinus. Slight hypertrophy of prostate. Hypertrophy of bladder with diverticula and cystitis. Diphtheritic ureteritis. Pyonephrosis. Diphtheritic pyelitis and suppurative nephritis on the left. Senile atrophy of right kidney. Hypostatic pneumonia.

Kidneys. Left renal pelvis and calyces dilated and filled with foul, thick fluid. Adherent to the walls of the calyces and pelvis is a grayish pink membrane. The capsule of the left kidney is adherent, surface is extremely granular. Here and there on the surface are whitish slightly elevated areas 2-3 mm. in diameter containing pus. The cortex is thinned. The right kidney shows slightly adherent capsule. The pelvis of this kidney is slightly enlarged, otherwise negative. The right ureter is negative.

No Microscopical Examination of the kidney is recorded; no autopsy cultures.

Sections Stained for Bacteria. No kidney tissue was preserved, section of prostate used. The miliary abscesses in the prostate show staphylococci, a few chains of streptococci and many bacilli.

Case 57. *Autopsy* No. 1197. West Surgical 465-67. Male, 40. March 15, 1904.

Present Illness. Fracture of vertebra of twenty-four hours standing.

Urine, on entrance, small trace of albumin, a few finely granular and epithelial cell casts, leucocytes.

Operation. Laminectomy.

No other urinary examination recorded. From entrance patient ran an increasingly high temperature and died twentieth day.

Clinical Diagnosis. Fracture of dorsal vertebra.

Autopsy. 72 hours post mortem. *Anatomical Diagnosis:*

Fracture first lumbar vertebra. Crushed cord. Operation wound—laminectomy. Septic wound. Meningitis. Abscess of right lung. Double empyema. Abscesses of kidney and prostate. Cystitis. Potts' fracture of left leg. Streptococcus septicemia.

Kidneys. Combined weight 365 grams. Capsules easily removed, revealing small abscesses on the surfaces of both kidneys. In places these abscesses extend a distance into the cortex and in a few instances as streaks as far as the tips of the pyramids. The kidneys are not dilated, ureters are free. The bladder presents an ecchymotic gray red mucosa. The prostate shows an abscess 3 cm. in diameter of the right lobe.

Microscopic Examination. Sections of the kidney show abscesses.

Bacteriological Report. Cultures from the heart, liver and spleen show staphylococci and streptococci. *Cover glass preparations* from the pus in the wound show streptococci.

Sections Stained for Bacteria. Abscesses in the kidney tissue show clumps of streptococci and staphylococci. In one abscess there are two large masses of bacteria, one of which seems entirely streptococcus infection, the other entirely staphylococcus infection.

Case 58. *Autopsy* No. 1731. West Medical 644-161. Female, 32. June 30, 1906.

Past History. Four years ago post-puerperal sepsis.

Present Illness. One week ago began to have recurrent attacks of chills without other symptoms. Patient came to hospital in prostrated condition; high temperature, pulse and respiration.

Urine. Very slight trace of albumin, moderate number of red blood and pus cells. *White count* 13,000.

Patient continued to grow worse and died fourth day.

Clinical Diagnosis. Septicemia, origin unknown.

Autopsy. 19 hours post mortem. *Anatomical Diagnosis*: Malignant endocarditis of mitral valve. Bronchopneumonia.

Purpura hemorrhagica. Infarcts of spleen and kidneys. Suppurative nephritis. Septicemia staphylococcus pyogenes aureus. Early pregnancy and abortion.

Kidneys. Combined weight 329 grams. The capsules strip easily, leaving a dark reddish surface dotted over with minute yellow points, dark red spots and here and there small irregular confluent abscesses. The small yellow areas mentioned are seen to be the outer surface of fairly firm homogeneous masses surrounded by blackish red kidney tissue from which they are sharply marked off. In some places these infarcts are situated in the cortex, while in others a few extend from the bases of pyramids to the cortex. In the pyramids are to be found numerous yellow streaks and spots. The cortex measures 5-6 mm. The mucosa of the pelvis shows minute blackish-red spots. Ureters and bladder are normal save for a few ecchymotic areas.

Microscopic Examination. The kidneys show necrosis with abscesses and hemorrhage.

Bacteriological Report. Cultures from the heart blood and spleen show pure growth of staphylococcus pyogenes aureus.

Sections Stained for Bacteria show in the discrete abscesses mixed infection of streptococci and staphylococci. In many places the vessels are found plugged with bacteria, most of which are streptococci, although all were found to contain considerable numbers of staphylococci.

Case 59. *Autopsy* No. 1081. South Surgical LXXIX-97. Female. June 26, 1903.

Present Illness. One week of acute abdominal pain with high fever finally localizing in the gall-bladder region.

Urine. Neutral reaction, trace of albumin, occasional blood and pus cells, no casts. *White blood count* 80,000; *temperature* varied from 100°-104°. Patient was not operated upon, and died of sepsis on seventh day.

Clinical Diagnosis. Cholelithiasis, cholecystitis, suppurative nephritis.

Autopsy. 4¾ hours post mortem. *Anatomical Diagnosis*: Pyonephrosis. Pyelonephritis. Cholelithiasis. Icterus. Fibromyoma of the uterus.

Kidneys. Left kidney is apparently normal, right kidney is enlarged and its capsules strip leaving a smooth surface, dotted here and there with minute yellowish abscesses. On section the tissue is soft and section surface shows numerous minute purulent areas. The cortex is of good width; the pelvis is dilated and contains yellowish-brown foul purulent material. Ureters and bladder show nothing remarkable.

Microscopic Examination. Sections of the kidney show the usual appearance of pyelonephritis. Sections of the left kidney show only edema.

Bacteriological Report. Cultures from liver and spleen show scum of growth of bacilli.

Sections Stained for Bacteria show considerable numbers of Gram-negative colon-like bacilli in the arteries and in some of the tubules while a considerable number of a smaller Gram-positive bacillus are to be found in abscess areas.

Case 60. *Autopsy* No. 285. East Surgical 338-116. Male, 80. June 14, 1898.

Present Illness. Patient admitted for retention. Could give no information about himself.

Temperature, 100°; vomiting; died soon after entrance.

Clinical Diagnosis. Enlarged prostate.

Autopsy. 19 hours post mortem. *Anatomical Diagnosis*: Adenoma of prostate. Diverticulum of bladder. Slight dilatation of ureters. Suppurative nephritis. Arteriosclerosis. Senile emphysema of lungs. Papillary adenoma of kidneys.

Kidneys. Capsules somewhat adherent. Cortex of each kidney somewhat narrowed. Kidney tissue pale, opaque and soft. A few small abscesses beneath the cortex (Plate XXXII, Fig. 32). Cultures of the heart blood—no growth.

Cultures from the kidney show several varieties of cocci and bacilli which are not differentiated.

Microscopic Examination. Kidney shows in the cortex extensive areas of infiltration of leucocytes with some disintegration of the renal epithelium. Glomeruli are not remarkable. Arteriosclerosis of the vessels, some areas of fibroid atrophy and round cell infiltration.

Sections Stained for Bacteria. The predominating organisms in the abscess cavities are two types of bacilli, one a Gram-negative bacillus probably b. coli, the other a long barred Gram-positive bacillus.

NOTE

These two bacilli clearly seem the etiological factors in the production of suppuration, although occasionally cocci are found. This case shows considerable post mortem invasion which may explain the presence of the variety of organisms found, yet the occurrence of the two bacilli described above in large numbers and confined to abscess cavities seems to indicate that they are the etiological factors.

The Lesions of So-called Ascending Infection Are Histologically Indistinguishable from the Excretory Type of Lesion. It has been customary to assume that there was a definite lesion produced in the kidney by ascending infection. This is referred to again and again in the literature and is often spoken of as the typical lesion of ascending infection. That this distinction cannot be maintained appears to us to be conconclusively shown by the two following cases (32 and 33). Without reproducing here the whole evidence printed above we may note that Case 32 was that of a man whose urine was normal at the time of entrance to the hospital. Following operation for cancer of the stomach, retention of urine took place and he was catheterized regularly until the day of his death three weeks later. During the process of catheterization, pus appeared in the urine and the case is typical of those

generally credited with being ascending infection. Case 33 was that of a woman, interestingly enough of exactly the same age, who died two weeks after an operation for fibroma of the uterus followed by infection of the wound. This patient had no urinary infection at the time of entrance, was not catheterized during her stay in the hospital and at autopsy showed a normal bladder. Nevertheless, the lesions of the kidneys in these two cases are indistinguishable, as a glance at the illustrations, Figs. 26 and 29, will show. These cases are typical of several occurring in our experience and we think they are sufficient to require an abandonment of the belief that there is any lesion of the kidney typical of ascending infection.

The Bearing of the Above Observations Upon the Diagnosis of Renal Infections. If we have succeeded in establishing the fact that the pyogenic organisms produce lesions of the kidney essentially different from those produced by non-pyogenic organisms it follows that this fact has an important bearing upon diagnosis. In the first place, it has, we think, been abundantly demonstrated by the testimony of many observers that organisms concerned in renal infections appear promptly in the urine though they may not long continue to so appear. That organisms not concerned in renal infections may also appear in the urine is to be remembered. The evidence above referred to of the appearance of tubercle bacilli and lepra bacilli after the administration of salvarsan, the recent observations of Dr. William H. Smith in regard to the appearance of organisms in the urine of patients with fever probably caused by a septicemia, and a mass of extremely careful evidence all bear upon this point.

On the other hand, with clinical evidence suggesting a renal infection, the diagnostic importance of a careful examination of the urine can hardly be overestimated. Thus the lesions characteristic of pyogenic organisms will show the

bacteria in the urine perhaps only during the early stages. Since, however, these lesions are comparatively shut off from the lower portions of the kidney and as they do not involve the pelvic mucous membrane, pus in any considerable amount will be found rarely if at all. By the same token, since the lesions of the non-pyogenic group are produced chiefly in the renal pelvis, evidence of this fact is abundantly clear in the urine by the early production of pus accompanying the appearance of the microorganisms.

A very striking difference is also to be observed in the effect on kidney function as measured by phthalein of these two types of infection. Since the suppurative infections involve chiefly the cortex and comparatively little the convoluted tubules, they would be expected to produce comparatively little effect upon kidney function thus measured, and such is in fact the case. On the contrary the chief lesion of acute renal infections with the colon bacillus group is first upon the convoluted tubule, the pelvic lesion, though appearing early, being, we think, secondary to the tubular lesion. This should, and in fact does, produce sudden and profound changes in kidney function; the case described on p. 169 being but one of a considerable series of observations which we have previously discussed in a paper on pyelonephritis.[1] Briefly and somewhat dogmatically stated, therefore, the diagnostic evidence is as follows: If with clinical evidence suggesting a renal infection, freshly drawn urine studied as suggested by Crabtree [2] shows cocci in abundance with a small amount of albumin, a few red blood corpuscles and many leucocytes or a little pus, together with a renal function at or near normal limits, a diagnosis of coccus infection of the kidney is justified. If, on the other hand, a similar examination shows many bacilli, a little albumin and much pus coupled with a markedly diminished kidney

[1] See Boston Medical and Surgical Journal, June 1, 1916.
[2] See Surgery, Gynecology and Obstetrics, February, 1916, pp. 221-224.

function, a diagnosis of colon bacillus infection of the kidney is unavoidable.

Though it is foreign to the title of this paper, it may not be improper to suggest the bearing of these observations upon treatment. Clearly the suppurative lesions concern those portions of the kidney which are relatively inaccessible to drugs and if these lesions are such as to require treatment, that treatment must be operative. On the other hand, the lesions produced by the colon bacillus group concern those portions of the kidney relatively accessible to formaldehyde-containing drugs and the surgeon is therefore justified in persisting in treatment by this method on the assumption that if it be properly planned and efficiently carried out it will succeed in controlling the infection. This statement must not be assumed to mean that we believe that the formaldehyde-containing drugs act upon the cells of the convoluted tubules. This we have no reason to assert, but the lesion of this portion of the kidney is a very transient one and such damage as is done by the acute process is rapidly overcome by the restorative action of the cells themselves. This particular lesion does not require treatment. It is the lesion of the pelvis and to some extent of the lower urinary tract that is the persistent and dangerous lesion, and this can be reached by formaldehyde.

Note

We wish to express appreciation of the valued services of Dr. James Homer Wright, director of the laboratory, for a lively interest in the work and for aid in collecting material. We have appreciated the privilege of appealing to his judgment on difficult questions arising during the progress of the work.

Dr. Oscar Richardson has kindly supplied from the autopsy room much valuable material.

Dr. William H. Smith has offered many helpful suggestions on the staining of bacteria in tissue.

Whatever of unusual merit our microphotographs may show is due to the painstaking thorough work of Mr. L. S. Brown.

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DISCUSSION

Dr. Geo. W. Warren, New York: I do not know when I have heard a paper of more interest than this paper of Dr. Cabot's. I am heartily in accord with what he has said.

It has always been hard for me to believe that organisms were carried to the kidney through the lymphatics. Adami proved some years ago that organisms entering the systemic blood stream were excreted by the kidneys. Then the work in connection with tuberculosis of the kidney, which was performed to prove that this infection was hematogenous, strengthens Dr. Cabot's contention. When the organisms injected into the blood stream were virulent the animal would die of miliary tuberculosis. But if the organisms were attenuated they would be excreted by the kidneys without producing any lesion, and if the culture was mixed with lycopodia and this mixture injected into the renal vein small infarcts of the kidney resulted and tuberculosis developed from these points.

Two or three years ago in cases of essential hematuria sections of the kidney were made and in all of these cases we could prove there was an infection. In all these kidneys examined there were arteriosclerotic changes and it seems to me that the blood stream in going through these thickened vessels was slowed and thus gave the bacteria a chance to rest at these points and multiply, starting an acute inflammation which later developed into a small celled infiltration.

It seems to me that the kidney is infected from an anatomical standpoint either through changes in the blood vessel—arteriosclerosis—which obstructs the blood stream, or from anatomical changes which obstruct the urine in its passage down the tubules, pelvis and ureter.

The only point I have to criticize in Dr. Cabot's able paper is the interpretation of his colon findings in his autopsy cases. The colon bacillus is constantly present in the organs at autopsy. So that finding the colon bacillus at autopsy does not necessarily prove, in my opinion, that the subject died of colon infection, as the colon invasion may have taken place post mortem.

Dr. H. L. Kretschmer, Chicago: I quite agree with Dr. Cabot

that the theory of infection via the ureter has been handed down for a long time, and that most of them do not occur in this way; that is, the infection usually does not ascend from the bladder through the ureter.

However, the pictures that I showed yesterday show that such a possibility may exist. If a patient has an infection of the bladder, and regurgitation of the urine through the ureteral orifice does occur, it is easy to see how infection may be transmitted from the bladder to the kidney, *via* the lumen of the ureter.

In this connection I should like to mention the possibilities of the bladder being a source of reinfection in cases of pyelitis. Bearing on this point I should like to mention a case of pyelitis that occurred in a young woman in whom we were able to obtain sterile kidney specimens after pelvic lavage, although we were unable to obtain sterile bladder specimens. Subsequently she developed a relapse of her pyelitis. Whether her pelvis was reinfected from the bladder by regurgitation or not I do not know, but I do think it is rather significant from the standpoint of her pelvic relapse; namely, that the infection had existed in her bladder and emphasizes the fact that in our pyelitis cases we should aim to clear up not only the pelvic infection, but the bladder infection as well. I was glad to hear that Dr. Cabot obtained so many positive blood cultures. We have not in our acute colon infections of the urinary tract been able to obtain positive blood cultures. Two cases in point; one patient came in with a picture of typhoid fever, we obtained positive cultures from the urine but were unable to obtain positive blood cultures. In one of our cases of pyelitis of pregnancy in which the temperature varied from 96° to 105° we were unable to obtain blood cultures.

One more fact that should be emphasized is the possibility of these infections having their origin in the bowel and being transmitted to the kidney by the lymphatics. According to Francke, the lymphatics of the colon traverse the capsule of the kidney, and according to Star, a direct lymphatic connection exists between the substance of the kidney and its fatty capsule, so that a direct route of infection from the bowel to the kidney is established. Ash attempted to prove this lymphatic connection experimentally. He administered opium to dogs until the bowels were thoroughly locked up. These animals soon showed colon bacilli in the urine. After administering

laxatives the colon bacilli disappeared from the urine. He made no blood cultures but he reasoned that the colon bacilli reached the urinary tract from the bowel via the lymphatics.

In many cases of pyelitis in children, a history of previous gastro-intestinal disturbance can be obtained, which might tend to substantiate these views.

Dr. William F. Braasch, Rochester, Minn.: I would like to ask Dr. Cabot if he found any anatomical conditions present which might cause urinary obstruction and so cause the hematogenous infection? It seems queer that there should be a hematogenous infection of the kidney without some anatomical interference with urinary secretion, since such obstruction is the rule in the majority of cases of infection in the lower urinary tract.

I also wish to revive the annual controversy between Dr. Cabot and myself with reference to the frequency of infection in the male and female. Since our last meeting I have paid particular attention to this point and I found that chronic renal infection occurs in the male fully three times as often as in the female. This may not be true with the acute infections, however. It would seem that the disparity in occurrence is based upon some anatomic ground.

Dr. E. G. Crabtree, Boston: I once had the same difficulty which Dr. Kretschmer speaks of in obtaining positive colon cultures. It is necessary to take the culture very early. If you take large quantities of blood during the first few hours of symptoms you can get positive cultures.

Regarding the direct transference of bacteria through the lymphatics from the intestine to the kidney, it is important to remember that it has been repeatedly shown that particles in the lymphatics of the peritoneum first enter the thoracic duct, then the blood stream, and bacteria behave in the same way. Probably a more careful following of the blood cultures in cases thought to be of lymphatic origin would answer these questions.

I have recently visited one of the animal experiment laboratories where I saw a number of cases of septicemias, in animals, unattended by any pathological change other than the occurrence of bacteria in the endothelial cells of blood vessels. The same bacteria were demonstrated in many cases in the urine. These observations were made during the last year at my request to see whether bacteria

occurred in urine in the pure septicemias. It seems to have occurred with regularity, in some cases even producing a pyelitis with thickening of the mucosa and infiltration.

I wish particularly to emphasize the point already made regarding the taking of large quantities of blood at the earliest opportunity if you are to expect a positive culture of the colon bacillus, because this type of organism very quickly passes through the kidney parenchyma.

Dr. G. G. Smith, Boston: I would like to ask Dr. Cabot whether he found any evidence in the kidneys of a pure pyelitis without an accompanying nephritic condition?

Dr. Cabot (closing): I want to point out that while I was the spokesman in this paper, you will readily see from the slides that have been put upon the screen that the very high degree of technical proficiency on the part of Dr. Crabtree has alone made this work of any value to any one.

In regard to the post mortem diagnosis of the colon bacillus, Dr. Warren is both right and wrong. Cultures post-mortem from the kidney showing the colon bacillus, especially if made some hours after death, are absolutely worthless; but in our cases the colon bacilli were shown in the tubules. Where they have actually gone through the kidney and appear in the tubules that is not a post mortem change.

In regard to Dr. Braasch's question as to the anatomic lesions, I have no doubt that infection of the kidney depends upon some condition of that kidney other than normal. I believe that some of those conditions are not demonstrable anatomic lesions. I believe there is such a thing as a kidney that feels kind of sick; that man is not as strong as usual. Many of these cases show perfectly clear anatomic changes. For instance, there is a group of cases here of perfectly typical so-called ascending infection in men with obstructive lesions, but unfortunately with a sterile urine, and the lesions in the kidney were pure coccus lesions which could not have ascended because there was nowheres for them to ascend from. Then again, here are slides which I did not show, showing two cases, one of them of typical ascending lesion in a patient in whom ascension might have taken place—I mean the lesion ordinarily described by the pathologist as the typical ascending lesion in a patient who had obstruction and bladder infection. Another precisely similar case in a woman

with sterile urine, normal bladder, in which operation showed an infection of the kidney microscopically precisely similar, in which ascension could not have taken place. There is no such thing as a typical ascending lesion of the kidney. Ascension must be shown to have taken place in that kidney or it cannot be asserted.

Again to cross swords with Dr. Braasch. I asserted last year that kidney infection was more common in the female than in the male. Following that, I did what I should have done before, I went back and looked the thing up and ran down a series of 600 cases in which the nature of the infection was known by culture and stain and in which the sex was determined, and I came to precisely the same conclusion that Dr. Braasch has appeared to come to, that the acute infections with the colon bacillus are enormously more common in the female than in the male; that the lesion which goes on to destruction of the kidney, the lesion that comes to the surgeon rather than to the physician, is more common in the male. Interestingly enough, these cases added up the same on both sides of the figure, but the chronic lesions are on the male side and the acute lesions are on the female side.

Now as to Dr. Smith's question in regard to pure pyelitis. I believe a pure pyelitis to be a myth absolutely. We found cases and we have here slides to show kidneys that show nothing but a pyelitis; in other words, thickening of the mucosa with bacilli demonstrated in the mucosa; but a thorough study of the history will always show a previous acute lesion of the kidney, a pyelonephritis. Now if those cases do not die you do not see them in the stage when the kidney disease is going on. Regeneration does in fact take place. In this patient who we showed clearly by his kidney function had an acute infection of his kidney, the bacilli disappeared and in that case did not show in the tubules. So that a pure pyelitis is the tail, of which the pyelonephritis is the cat, but the cat gets chopped off.

SUPERNUMERARY VEINS OF KIDNEY—RENAL CALCULUS—NEPHRECTOMY

By Henry H. Morton, M.D., F.A.C.S., of Brooklyn

IN normal subjects the renal veins are two in number, one returning the blood from each kidney. Each vein is formed at the hilum or some little distance from it by the union of three to five branches which come from the kidney substance.

The renal veins are occasionally replaced from two to seven vessels which open independently into the vena cava, a condition which probably depends upon the failure of the vessels from the different portions of the kidney to unite to a common stem. Accessory vessels which communicate with the vena cava below the level of the renals sometimes occur.

The explanation of the occurrence of accessory veins may be described as follows:

In the early stage of development, the kidney is drained by a plexus of small veins. In time the veins atrophy and all but one disappear.

In exceptional cases, however, it is possible that more than one of these small veins persist and remain as renal veins.

Such an instance is presented by the following case:

A woman, 44 years old, entered Long Island College Hospital, complaining of pain in the right flank extending around to the groin. Pain constant with exacerbations lasting for an hour or two nearly every hour and patient gets up two to three times at night to void small quantities. Examination of the bladder urine showed it to be acid, 1029, and contained many

PLATE XXXIII—Presented by Dr. H. H. Morton

red blood cells and many white blood cells. No casts were found. The radiograph showed a distinct shadow at the lower pole of the right kidney. On ureteral catheterization, both urines were very turbid and contained quantities of broken-down detritus. With chromocystoscopy, the indigo carmin did not show at all on the right side, but in fifty-five minutes there was a faint tinge on the left side. The right urine contained 11 grains of urea and the left side 16 grains.

These findings were not what we had expected, and so to check up our results we catheterized the ureters again a couple of days later. The right catheter was plugged with a bit of mucus and after thirty minutes the plug was dislodged and the indigo carmin was strongly visible, whereas only a faint tinge of blue appeared in thirty-five minutes on the left side. The right side contained 14 grains of urea while the left side contained 12 grains of urea. It was evident, then, that both kidneys were secreting freely and in this case our ureteral catheterization did not help out in the least in the diagnosis. It merely showed us that if it should be necessary to remove the kidney on the right side the left kidney was sufficient to support life.

For a diagnosis of stone in the kidney we had to depend on the shadow which showed in the radiograph. Putting the facts together, however, with a very distinct shadow shown by the radiograph, taken twice on different days, the shadow always being in the same place, with the constant and intense pain which disabled her and rendered her physically incapable of doing her work, and with the knowledge that we had a sound kidney on the left side, I considered it at least justifiable to do an exploratory operation and inspect the kidney and probably find a stone somewhere in the kidney which is evidently so placed as not to interfere materially with the secreting function.

Operation. Usual oblique incision made over the kidney. Exposure was difficult on account of an immense layer of fat,

at least two inches thick, lying over chest and abdomen. Kidney exposed, and lifted out on the flank. A good deal of venous hemorrhage occurred which was temporarily controlled by a clamp on the kidney pedicle. Hemorrhage being arrested —I proceeded to explore the kidney. Palpation disclosed a resisting area at the lower pole. As the stone was too far removed from the pelvis of the kidney for pyelotomy, I incised the thin kidney tissue over the stone and with forceps grasped and removed an irregular stone with one long projection extending into the calyx of the kidney.

Exploration of the pelvis of the kidney through the incision and careful palpation over the kidney failed to show any more hardened areas.

After suturing the incisions in the kidney, I loosened the clamp on the pedicle and noted free bleeding from several veins which I proceeded to ligate, tying off three, but the bleeding still continued. Dressing with gauze packed around the kidney did not control the bleeding at all.

It was evident, then, that neither ligation of the torn veins nor packing would control the hemorrhage, and nephrectomy seemed to be the only resource.

I accordingly ligated the pedicle and removed the kidney.

On splitting the kidney after its removal, I found it to be perfectly sound, except at the lower pole, where there was a small area of chronic inflammation surrounding the calculus, which I had removed—but nothing to cause the bleeding.

On examining the blood supply the renal artery was plainly to be seen, but on looking for the renal vein I found it to be absent.

In its place, however, were five small veins which go into different parts of the kidney and its pelvis; an anomalous distribution of the blood supply.

This abnormality of the veins explains the uncontrollable hemorrhage.

On account of the layer of fat, 2 inches thick, it was neces-

sary to draw the kidney out to a considerable distance to expose the pelvis, and the tension was too great for the five thin-walled veins to stand the strain. Consequently tears took place in the walls and hemorrhage occurred.

Since I have discovered the anomalous distribution of the veins, I feel that I did the correct thing in taking the kidney out, since the ligation of the veins would not control the hemorrhage, although it seems a pity to sacrifice such a good organ as this kidney evidently was. These anomalies do occur, but this is the first time I have happened to meet with one. We have at least the satisfaction of having an interesting specimen to place in the anatomical museum, although I daresay the patient would rather not have made such a contribution.

MIXED TUMOR (SARCOMA) OF THE KIDNEY REMOVED FROM AN INFANT TWENTY-ONE MONTHS OLD; RECOVERY

By Alfred C. Wood, M.D., of Philadelphia

R. A., male, aged 21 months, was seen in consultation with Dr. J. H. Davis, Coatesville, Pa., Feb. 10th, 1916. The following history was obtained. He is the youngest of six children; he has always appeared to be perfectly well. He eats, sleeps and plays normally; he is well nourished, and gives no evidence of any discomfort. The bowels act naturally and the kidney function appears to be normal.

The parents are both in good health. There is no history of any tumor in any member of either family. The father's age is 35 years and the mother's 37 years.

The other children, aged 13, 11, 10, 8, and 5 years, respectively, are well in every particular. The mother does not recall any unusual incident during the time she was carrying this child.

The tumor was discovered by accident. During a professional visit to another member of the family Dr. Davis found the subject of this report lying on a couch. He stopped for a moment to amuse the child, during which he chanced to place his hand upon the abdomen and at once felt an unusual resistance. Further examination disclosed a well defined tumor in the right side of the abdomen, extending from the costal border nearly to the ilium. It was not tender, was slightly movable, smooth and uniformly hard.

Upon close questioning the mother thought she noted that

PLATE XXXIV—Presented by Dr. A. C. Wood

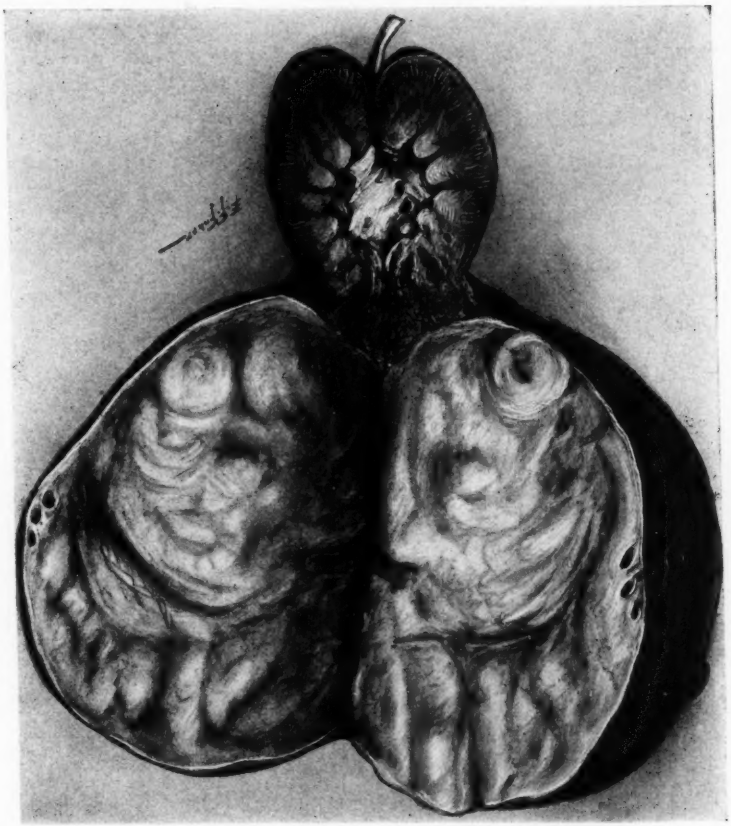

Fig. 1. Section through kidney and tumor, showing tumor springing from lower pole of kidney.

the child's abdomen seemed unnaturally hard when she bathed him, but the impression was not sufficiently clear to cause her to make any comment upon it.

Examination. The child is well nourished and has the appearance of good health in all particulars except that the abdomen is unduly prominent, and enlarged veins are visible on the right side of the abdomen and in the right flank. Palpation reveals a firm, smooth, resistant, slightly movable tumor in the right side of the abdomen, extending from the right costal border into the pelvis and to the left beyond the middle line. It gives a dull note on percussion. Pressure did not elicit any pain. It was also plainly felt in the ilio-costal space. (Dr. Davis stated that it had enlarged greatly since his first examination, six or eight weeks before.) The sensation imparted to the examining hand was that of a solid mass, which on account of its location and character was thought to be connected with the kidney. The urine had been examined by Dr. Davis, and was found to be normal.

Operation on the same date. The abdominal cavity was opened by an incision in the right semilunar line, and the diagnosis of tumor connected with the right kidney confirmed. As the left kidney appeared to be normal it was decided to proceed with the removal of the tumor. The peritoneum was incised external to the ascending colon and the latter displaced inward, exposing the mass. The enucleation was tedious on account of firm attachments in places, and a few large veins were encountered, but the removal was accomplished without great difficulty. The operation was concluded by suturing the posterior peritoneal wound and the abdominal incision. The operation was well borne, the child reacted well and convalescence was rapid and uninterrupted until the 9th day, when it developed measles and was removed from the hospital to its home. However, no untoward results followed and it recovered fully both from the operation and from the measles.

The child was last seen July 10th, 1916. He appears to

be in perfect health in every particular. He has grown since the operation, is very well nourished and his mother said he was as bright and playful as the other children. Careful palpation of the abdomen did not disclose any evidence of recurrence of the growth.

Pathological Report. The specimen was submitted to Dr. Allen J. Smith, Professor of Pathology in the University of Pennsylvania, who reported as follows: The gross specimen consists of a small kidney 5.5 cm. in length, the lower pole of which is expanded over the top of an ovoid tumor 13 cm. in length and 8.5 cm. in its transverse diameter. The surface of this growth seems to be covered by a continuation of the capsule of the kidney. A number of small bosses, some of which are soft and approaching a cystic condition, appear here and there upon the surface, which is otherwise smooth, showing in its thin covering the injected lines of blood vessels. The tumor in general is firm and fleshy in consistency, and when laid open its substance is pale in color, translucent, with a small patch of what seems to be fatty material near the central part. A few coarse subdivisions by fibrous strands extend through the growth. It apparently does not involve the kidney proper, which is sharply defined at its lower pole from the tumor, a white fibrous capsule intervening. The tumor and kidney together weigh 880 grams.

Sections show the tumor definitely separated from the kidney tissue by a thick fibrous wall containing numerous connective tissue cells; and the bordering renal tissue is atrophic and sclerosed.

The tumor presents the histology of a polymorphous cell sarcoma for the most part, with here and there scant strands of fibrous tissue entering it and with now and again fibrous or fibro-cellular areas in it. No strands of striated muscle tissue were found, but in one of the sections strands of smooth muscle fibers, with long slender nuclei, were detected. In the midst of the sarcoma cells at places are numerous openings of

small but variable size, lined by delicate epithelium and containing a granular, hæmatoxylin-stained precipitate. These are probably lymph vessels, although it is difficult to account for the hæmatoxylin election by the fixed granular contents. The sarcomatous tissue is, for the most part, made up of round cells of intermediate size, but there are areas where spindle cells alone are to be seen; and usually spindle cells are scattered among the round cells. In size there is only general uniformity, definite small and definite large cells of both round and spindle varieties being visible among the ordinary medium sized elements. The inter-cellular substance is scant and fibrillar in character. The growth is not highly vascular; the vessels are thin walled as in sarcoma.

A study of the reports of cases similar to the preceding in current medical literature, must impress one with the fact that as yet there is no unanimity of opinion in regard to renal tumors occurring in infancy and early childhood. The following terms have been employed by the various authors in describing these cases:

Adenoma, adenomyosarcoma (Wilm's), angiosarcoma, carcinoma, embryoma, embryonal adenosarcoma (Birch-Hirschfeld), embryonic sarcoma, endothelioma, fibro-adeno-rhabdomyomatous mesothelioma, Grawitzian tumor, hypernephroma, malignant adenoma, malignant embryonal adeno-carcino-sarcoma, mesothelioma (Adami & McCrae; Stewart), mixed tumor of embryonal origin (Bendell), myxosarcoma, myxosarcoma strio-cellulare (Ribbert), nephroma, nephroma embryonale malignum (Trappe), perithelioma, renal sarcoma of infancy, rhabdomyoma, rhabdomyosarcoma, sarcoma, teratoma, Wilm's tumor.

It will be observed that in most instances the name merely indicates the tissues observed in the microscopic examination of the tumor. While it must be admitted that the kidney may be the seat of different types of tumors in infancy as well as in adult life, it is obvious that the foregoing list is no indica-

tion of the actual number of legitimate varieties. Until the problem of the etiology of tumors is solved, any classification will probably be unsatisfactory. A part of the confliction of opinion that exists in regard to this particular form of neoplasm may be explained first, by the fact that these tumors are usually, if not always, of "mixed" type, and hence it is necessary to examine every part, otherwise some of the elements present may be overlooked; and, second, pathologists sometimes differ in their interpretation of certain histologic appearances.

In 1870 Catanni definitely recognized the sarcomatous character of a kidney tumor. Prior to that time these cases had been called "cancer" or "malignant tumor" of the kidney. In 1884 A. Jacoby showed that most of the reported cases were sarcomas. The "mixed" character of these tumors was recognized by Eberth and their embryologic origin by Cohnheim (Shannon).

In 1883 Grawitz published an article in Virchow's Archives (Bd. 93), in which he showed that the small tumors resembling fat occasionally found in a cortex of a kidney were displaced portions of adrenal cortex, and the large tumors having a somewhat similar appearance resulted from the active growth of these masses. He called these tumors "strumæ lipomatodes aberratæ renis." Lubarch, writing in Virchow's Archives in 1894, applied the term "hypernephromata" as a more convenient name. It should be stated that these are wholly distinct from the class now under consideration, and are mentioned here merely to record briefly a few of the more important contributions to the classification of kidney tumors. It would seem, however, that the distinction is not always observed in reporting cases. That this subject is not as simple as could be wished will appear from the following.

Accessory adrenals composed of cortical tissue may occur in the adrenal tissue or its capsule or even in the kidney. When these hypertrophy, an adenomatous type of growth re-

PLATE XXXV—Presented by Dr. A. C. Wood

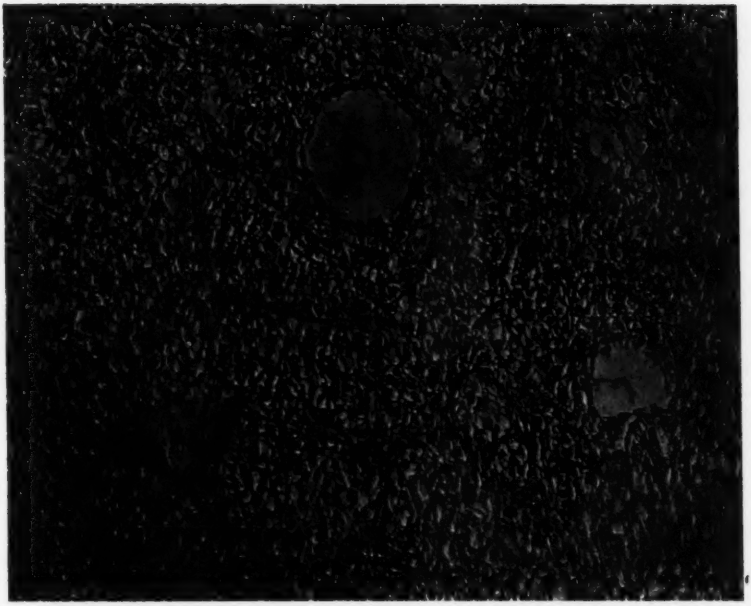

Fig. 2. Photomicrograph of tumor.

sults. These tumors show the typical cortical tissue with columns of cells in a meshwork of capillaries; they may occasionally reach large proportions. On the other hand, there are tumors which in certain parts resemble the preceding, while in other parts are cells of smaller size, less deeply stained and containing less fat with transitions from adenoma to sarcoma and even with the presence of definite sarcomatous tissue. The metastases are clearly sarcoma. These tumors have been called homotopic hypernephroma in contradiction to the Grawitzian type, which is heterotopic hypernephroma. There is at this time no agreement of opinion in regard to the real nature of these tumors, for instance, some may arise in the kidney cortex, quite independently of any adrenal displacement; hence a true nephroma. The cortex of the kidney and that of the adrenal are closely related embryologically, so that tumors of these structures might be expected to possess closely related connections. These tumors are usually vascular. The cells are in close contact with the capillaries. They are prone to hemorrhage. Metastasis by the blood current is common and the tumor tends to grow along the veins to the vena cava. (Adami & McCrae.)

In 1894 Birch-Hirschfeld pointed out that the infantile tumors of the kidney are identical in character and origin, and differ only in the proportions of the various elements present, of which two are especially typical (glandular tubules and undifferentiated embryonal cells). He called attention to the resemblance of these tumors to the early Wolffian body, and concluded that they originate in rests of this structure, which have become included in the kidney during its development, just as a portion of suprarenal gland may become displaced. He proposed the name "embryonal adeno-sarcoma."

Muus held the opinion that these tumors develop from rests of the early fetal kidney on account of the similarity of their structure to this body. Wilms advanced the theory that these tumors are a development from common mother cells of myx-

oma-like tissue, which he believed represent mesodermal cells in a very early stage of the embryo. These would normally later develop into pronephron and myotome. When, from some cause, these cells lose their normal connections, they remain for a certain length of time as so-called rests, and subsequently take on rapid growth, producing a tumor composed of the various types of tissues which would have formed if they had maintained their normal relations. At the stage indicated all the elements found in these tumors are in close proximity, and the various degrees of displacement of portions of these elements account for the variations observed in the tumors. It thus happens that some of the cells develop along the lines of the Wolffian body while others form muscle, cartilage, bone, etc.

Adami and McCrae explain certain forms of these tumors as follows. The distal collecting portion of the renal tubules are derived from the Wolffian duct and the glomerular epithelium, and main part of the tubule from the mesenchyme. As the primitive kidney is intimately associated with the Wolffian duct, tumors arising in these structures also involve the germinal mesothelium. It follows, therefore, that while pure adenomas are met with, which show no evidences of reversion, various transitional tumors occur, which in parts show the structure of adenoma and in other parts of sarcoma. In other areas one passes insensibly into the other.

When one turns to the clinical aspect, the problem is very much less complicated. For the clinician, at least, the suggestion of Bendell that these renal growths occurring in infants should be called "mixed tumors of embryonal origin" would seem to be satisfactory in the present state of our knowledge. Expressed as concisely as possible, and yet fully describing the case, one might say embryonal renal mixed tumor. While embryologists may differ as to the origin, and pathologists as to the classification of these tumors, no difference is apparent clinically; they all seem to run a similar

course, namely, they occur in very early life, they grow rapidly without causing pain or other involvement until late, and they invariably end fatally, unless relieved by operation.

Histology. The histology of these tumors is indicated in the various names under which they have been reported. In many cases there is a basis of sarcomatous tissue, composed of round, spindle or mixed cells with admixture of various amounts of one or more of the following: myxomatous tissue, cartilage, bone, unstriped and striped muscle fibers, and embryonic connective tissue.

An analysis of the cases reported in recent medical literature shows the following facts.

Age. The class of tumors under discussion may be present at birth or may appear at any time subsequently. Rarely both kidneys may be affected simultaneously, or one may be involved after the other. Van der Byl is reported to have performed nephrectomy for tumor of the kidney on a boy, 14 months old, who 4½ years later was found to have a sarcoma of the remaining kidney (Loughnane).

In a collection of 106 cases of these mixed kidney tumors 3 were present at birth; 7 appeared in the second half of the first year; 19 between one and two years; 13 between two and three years; 18 between three and four years; 10 between four and five years; 20 between five and thirteen years; 7 were in adults between eighteen and fifty-four years; age not stated in 9. (Wollstein.)

Of 219 cases, 34 occurred in the first year; 55 in the second year; 168 in the first five years.

In 548 cases one-third occurred in the early part of the first decade (Rosenstein). Rohrer states that one-third of all malignant renal tumors occur in children.

Frequency. In 4,500 postmortem records only 9 primary renal tumors were observed (Kelynack); in 37,000 postmortem records reported by Küster only 23 primary renal tumors were observed. Warthin analyzed the autopsy records of

2,000 cases of malignant neoplasms occurring in persons up to the age of 30, and found but four sarcomas of the kidney, one rhabdomyosarcoma, one adenosarcoma (congenital), one adenorhabdomyosarcoma, all three in the first year of life, and one rhabdomyosarcoma in the third year. Renal tumors are said to comprise 2 per cent. of all the neoplasms of the body. Cheney examined the records of 2,260 cases of diseases in infants and children under 12 years of age applying at the clinic of the Cooper Medical College in San Francisco during the ten years from 1897 to 1906, and there was no case of sarcoma of the kidney.

Loughnane found that but 35 cases had been treated at the principal London hospitals from 1900 to 1912 inclusive. Twenty-six of these were confirmed by operation or autopsy. During the same period the report of the Registrar-General of the United Kingdom showed 557 deaths from "Cancer of the kidney and supra-renal capsule" under 15 years of age. Many of these cases may not belong to the class under discussion, but it is clear that too frequently these patients are not brought to the hospitals for advice.

Side Affected. Of 35 cases, 17 were on the right side and 13 on the left side; both sides were affected in one case, and in 4 the side was not stated (Loughnane). Of 59 cases of malignant tumor of the kidney, 31 were on the left side; 26 on the right; 2 not stated (Willan). These figures are too few to establish a rule, but they at least suggest that one side is as likely to be affected as the other.

Sex. In 49 cases of malignant renal tumor in the adult 63.8 per cent. were in males. Of 10 cases in children 6 (60 per cent.) were in boys (Willan). Of 557 cases of death under 15 years of age from "cancer of the kidney and supra-renal capsule," contained in the report of the Registrar-General for the United Kingdom, from 1901-1911 inclusive, 272 were boys, and 285 were girls.

Symptoms and Signs. These cases do not present any

"early" symptoms. The first evidence of tumor of the kidney in infants to be observed by the mother, in the great majority of cases, is enlargement of the abdomen. This has been present at birth, occasionally, but usually develops at a later period. In most of the cases this remains the only manifestation until the size of the tumor interferes with the functions, or metastases undermine the child's health. Loss of appetite and strength follow and the resulting emaciation still further emphasizes the abnormally large abdomen. Cachexia may be present. Hematuria has been observed in a few cases. Albuminuria, with or without casts, may be present. Of 35 cases blood or albumin was present in 10 (Loughnane). It is usually not accompanied by pain. A chronic discomfort or ache in the affected side has been reported in rare instances. Fever may be present in rapidly growing sarcomata. The superficial abdominal veins on the affected side are sometimes much enlarged.

The tumors are readily recognized by palpation. They are uniform, hard, painless, moderately movable, and may be outlined posteriorly by bi-manual examination. Having reached a sufficient size to be noticeable, growth is apt to be rapid, and the progressive enlargement may be recognized at succeeding examinations.

Diagnosis. Tumors of the kidney are usually readily felt by careful palpation. They begin under the costal border on one side and develop downwards toward the pelvis and inward toward the middle line. It will be remembered that the kidney being retroperitoneal is behind the colon, whereas the liver and gall bladder on the right side, and the spleen on the left side, are in front of the colon. The firmness of these tumors is in contrast with the congenital cystic kidney and hydronephrosis. In older children and in adults such aids as segregation of the urine from the two kidneys, ureteral catheterization, functional tests of each organ, X-ray examination, and pyelography in addition to the general physical in-

spection and the urine examination should always be employed. These measures are not all available in infants. Congenital cystic kidney and hydronephrosis are to be excluded.

Prognosis. These tumors are uniformly fatal. Although they may be present in an undeveloped condition for a more or less prolonged period, after they have become large enough to be seen and easily palpated, they increase rapidly in size and lead to a fatal termination unless removed.

Treatment. Removal of these tumors at the earliest possible moment offers the only hope of saving the child's life. Unfortunately the majority of the cases will succumb to recurrences or metastases, but some of the cases have remained well after removal of the tumor; the number of these favorable results would no doubt be greater if the cases could be discovered and operated on earlier.

Operation. Both the lumbar and the transperitoneal routes are recommended for the removal of these tumors. The majority favor the former on the ground that the peritoneal cavity is thus not opened and by carrying the incision well forward, even to the border of the rectus muscle, ample room is provided. This method is suitable in adults or in older children in whom a complete study of the case has been possible, and the diagnosis thus fully established. In infants, however, in whom it is impossible to carry out many of the methods of examination employed in adults, it is, it seems to me, desirable to operate by the transperitoneal method, which not only permits of confirming the diagnosis but enables one to determine the presence or absence of the opposite kidney, and if present its gross condition. Whenever, therefore, the diagnosis is in any doubt, or the presence of a sound kidney on the other side has not been established, I would incline toward the abdominal route. The dread of opening the peritoneal cavity formerly felt by surgeons no longer exists, so that the arguments against this route have lost their force.

In all of the reports that have come under my notice, the

kidney affected has been removed with the tumor, except in one instance. In 1892 Dr. Robert Abbe operated on an infant one year of age for a large tumor of the right kidney. Dr. Abbe says, "one unusual feature of the case was that while the growth was incorporated with the upper part of the kidney the lower half was apparently free; he therefore ventured to amputate this and closed the cut section by continuous catgut suture." The child made a good recovery and 20 years later the patient was still in good health.

In the case forming the basis of this report, the same question arose during operation. The tumor was attached to the lower pole of the kidney, the upper portion of which looked entirely normal. The propriety of amputating the tumor through what seemed to be healthy kidney structure was discussed, but I feared that some malignant elements might thus be allowed to remain, hence the kidney was removed entire with the tumor. I was not at that time familiar with Dr. Abbe's case or I should probably have followed the method which he adopted.

Results of Operation. The immediate mortality, which was formerly very high, is becoming less and less with improved technique. In 1885 it was put down as 76 per cent.; in 1902 as 22 per cent.; in 1914 as 7.7 per cent. (Loughnane). Various other figures have been given at different times: 30 per cent. (Albarran); 32 per cent. (Schmiden); 25 per cent. (Küster); 20 per cent. (Isreal). Bland-Sutton gives the mortality of nephrectomy in children under 6 years of age as 50 per cent.

Recurrence is said to occur in 80 per cent. of the cases after operation and in over 70 per cent. recurrence takes place within the first year. After five years recurrence is rare. According to Bland-Sutton, of the 50 per cent. surviving operation 45 per cent. die from recurrence in from two months to a year; the remaining 5 per cent. life may be more or less prolonged. Permanent cures of from two to eighteen years have been reported in 34 cases (Wagner); 21 of these had

passed the three-year limit; one was alive and well at the end of eighteen years (Malcolm).

The most remarkable case of which I have seen reference was reported by Dr. Robert Abbe, who presented the patient before the New York Surgical Society, at its meeting April 24th, 1912. In 1892 he had removed a tumor of the right kidney in an infant one year of age. The tumor "proved to be a solid, sarcomatous structure, softer and semi-cystic in parts, resembling, as did many 'Grawitz' tumors, a section of a firm tomato. Upon removal, the tumor weighed 7½ pounds—just one-half the weight of the infant after its removal, which was 15 pounds.

The growth was submitted to Dr. Edward K. Dunham for pathological examination, and he pronounced it a 'rhabdomyosarcoma.'" The patient was still in perfect health at that time, 20 years after the operation.

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DISCUSSION

Dr. F. R. Hagner, Washington: I would like to report a case of sarcoma of the kidney in a child twenty-two months old. This was a male child, and the tumor had not been noticed until about two months before I saw the child. The tumor practically filled the whole abdominal cavity, the intestines being pushed to the opposite side. I was able to cystoscope this male child, and after injecting indigo-carmine saw urine coming from both ureters. At exploratory operation the tumor was absolutely fixed, and we felt sure its removal would cause the death of the child, so we discontinued.

PLATE XXXVI—Presented by Dr. W. C. Quinby

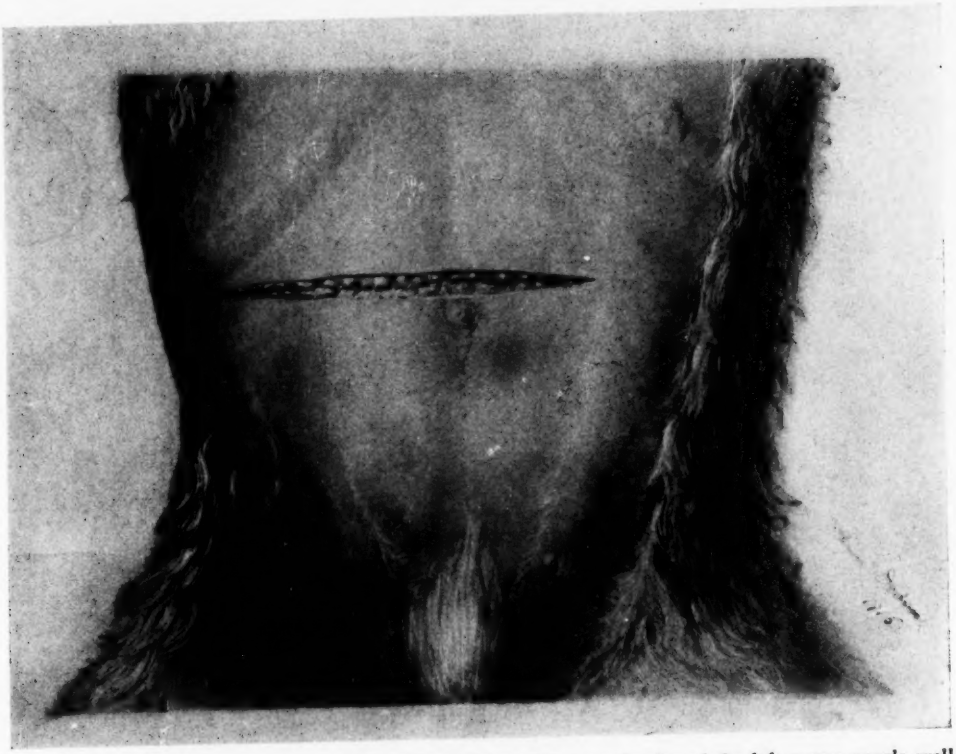

Fig. 1. The transverse abdominal incision extending from the outer border of the left rectus muscle well down into the right flank.

THE ACTION OF DIURETICS ON THE DENERVATED KIDNEY [1]

By William C. Quinby, M.D., of Baltimore

THAT the plexus of nerves going to the kidney has a marked vasomotor function is everywhere admitted. Besides this action, however, certain observers have claimed that some of these nerves were of specific secretory function. By others this has been denied. Certain investigators attempt to show that the vagus carries such secretory fibers to the kidney, while others attribute such to the splanchnics.

The difficulty in reaching a conclusion on the subject has been in the main due to two causes. In the first place, stimulation or section of vagus or splanchnic causes such marked vasomotor changes that any possible secretory effects are easily overshadowed; in the second place, the operation which attempts the division of the plexus of nerves at the renal pedicle has given inconclusive results because of the uncertainty that all the nerves were cut.

To meet this difficulty it was determined to study the function of a kidney which had been removed from the body and subsequently restored to its normal circulation by means of suture of the blood vessels. In this way it is possible to be sure that the kidney is freed from all nerve control, for a time at least.

The results of this portion of the work have been reported in the Journal of Experimental Medicine for April, 1916, and will be only briefly summarized here.

[1] From the James B. Brady Urological Institute.

By transverse incision a dog's kidney was made accessible. After being surrounded by silk cloths, impregnated with liquid vaseline, the structures forming the pedicle of the organ were cut, and the kidney removed from the body. A suture of artery, vein and ureter was then made, by which the circulation was restored after an interruption of about one hour. At varying periods after this operation the function of the kidney was studied by comparing it with that of the intact kidney.

The result obtained from this series of observations showed that the function of the reimplanted kidney was greater than normal during the days immediately following operation until about two weeks had passed, when it was found normal. These facts are illustrated in the accompanying table.

Dog 66 Two days after operation	Amount of Urine		Percentage NaCl		Amount of NaCl	
	Operated Side	Well Side	Operated Side	Well Side	Operated Side	Well Side
Before diuresis.....	5.cc.	2.5cc.	0.90	0.55	0.045g.	0.013g.
After diuresis.....	60cc.	22cc.	0.95	0.95	0.570g.	0.209g.
Dog 68 Fourteen days after operation						
Before diuresis.....	3cc.	2.5cc.	0.93	1.12	0.028g.	0.028g.
After diuresis.....	36cc.	40cc.	0.96	0.82	0.345g.	0.328g.

These observations together with the fact that it has been repeatedly possible for a single reimplanted kidney to maintain normal existence of the dog after removal of the kidney on the other side, tend strongly to exclude the existence of any specific secretory nerve fibers.

In this present communication the action of diuretics on such a reimplanted kidney has been studied. The methods by which diuretics act are, firstly, by raising the general systemic

PLATE XXXVII—Presented by Dr. W. C. Quinby

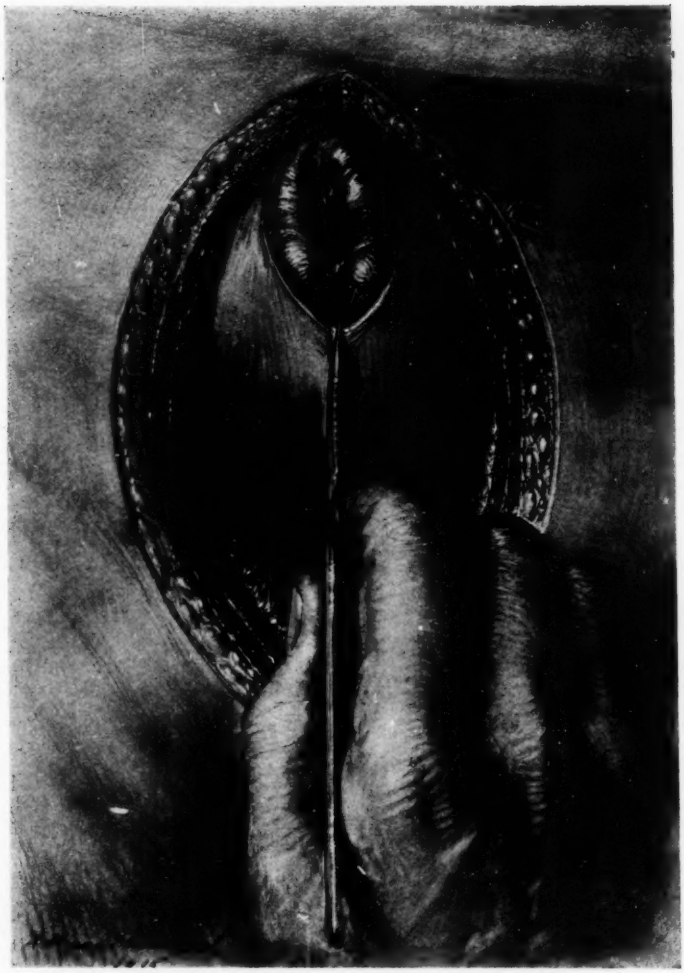

Fig. 2. The oblique muscles and both recti have been divided and the abdomen is being opened by incision of the transversalis in a direction parallel to its fibers.

PLATE XXXVIII—Presented by Dr. W. C. Quinby

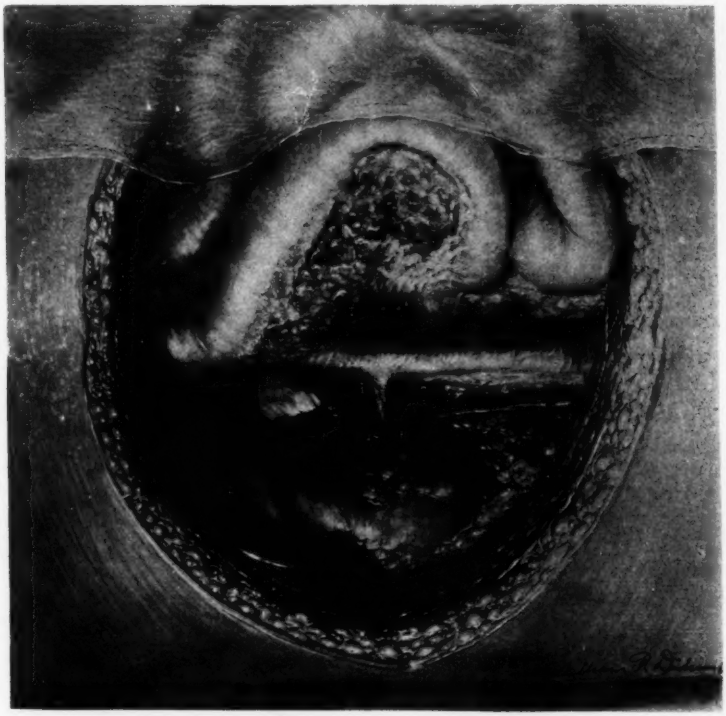

Fig. 3. The intestines have been withdrawn for the most part from the abdomen, and lie to the left covered by silk handkerchiefs. The kidney, with its vessels and ureter, lies well exposed. Above the kidney is seen a portion of one of the lobes of the liver. At its inner side lie the inferior vena cava, and the pancreas enclosed by a portion of the duodenum.

PLATE XXXIX—Presented by Dr. W. C. Quinby

Fig. 4. The oncometer. (From Roy.)

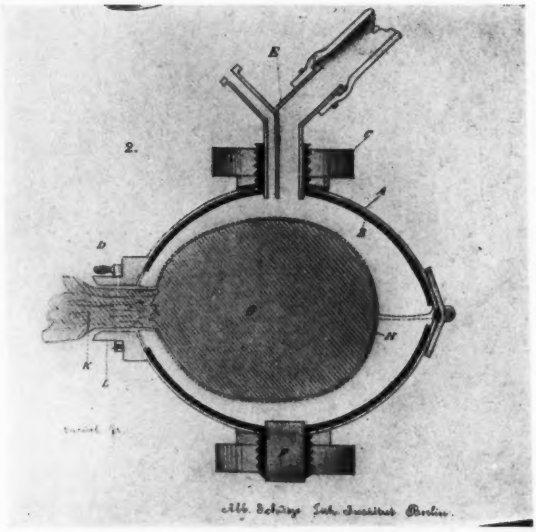

Fig. 5. Sectional drawing of oncometer to show detail. (From Roy.)

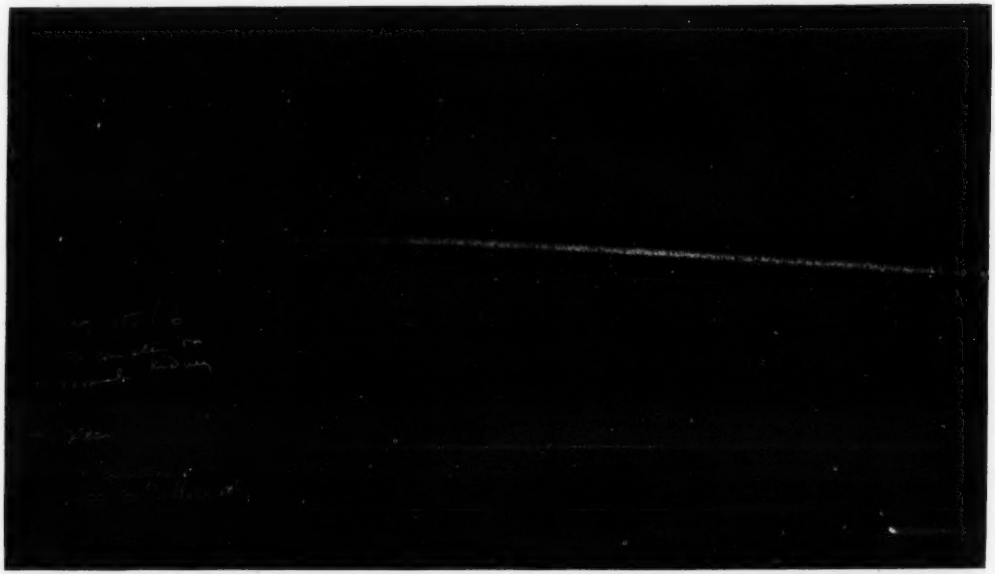

Fig. 6. The change in volume of the normal kidney caused by intravenous injection of 5 c.c. of a 20% solution of NaCl. The upper curve is from the oncometer; the middle one registers the blood pressure; while the lower shows the time in 2-second intervals. Note that there is a gradual rise in blood pressure together with increase in kidney volume. Synchronously with the rise in kidney volume the rate of flow from the ureter of that side was increased.

PLATE XLI—Presented by Dr. W. C. Quinby

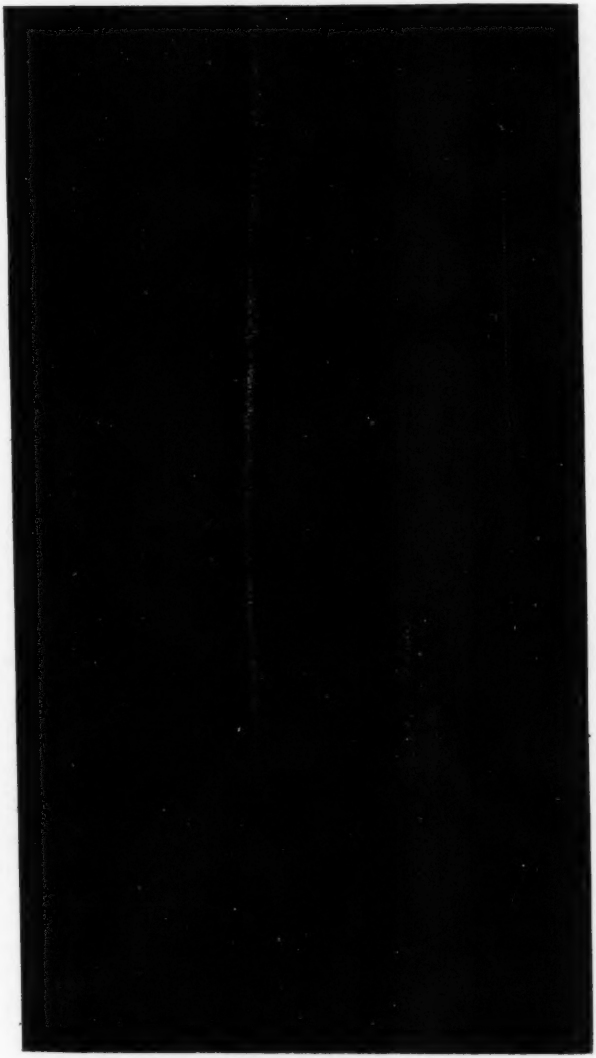

Fig. 7. The response of the denervated kidney to the same diuretic. Note the similarity of this tracing to that of Fig. 6. The apparent longer duration of the diuresis is due to a faster moving drum; the time in this instance being registered in single seconds.

blood pressure, an example of this class being sodium chlorid in hypertonic solution; secondly, by a local dilatation of the arterioles of the kidney; a group represented by urea; and possibly thirdly, by a paralytic action on the renal tubule cells preventing the absorption of water; an exponent of this group being caffein or diuretin. It is possible, however, that such diuretics as do not cause increase of general blood pressure may act by stimulation of secretory nerves if we suppose such to exist.

In order to register the action of the injected substances the kidney was placed in an oncometer of the type designed by Roy [1] and by it changes in the volume of the organ were recorded on the Kymograph. Observation of flow from the cut ureter of this kidney was also made.

A series of observations were first recorded from normal animals, after which the same method was applied to those bearing a reimplanted kidney. Examples of these tracings are given on PLATES XL and XLI.

As will readily be seen the types of reaction shown by the normal and reimplanted kidney are practically identical for the same diuretic.

Here again, then, as in the series of observations already reported, we are unable to find any evidence of abnormality on the part of the reimplanted kidney, its response to diuretics being the same as that of the intact organ. In other words, the reimplanted kidney shows no evidence of loss of any possible secretory nerve influence.

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[1] Cohnheim, J., and Roy, C. S., Untersuchungen über die Circulation in der Nieren, Virchow's Archiv f. Path. Anat., 1883, XCII, 443.

DISCUSSION

Dr. Geo. W. Warren, New York: I should like to ask if, in these cases where the kidney is stimulated by diuretics, he considers that increased blood supply to the kidney is the sole cause of the diuresis.

There seem to be some rather interesting points to consider along this line as, for instance, where one drug is administered and a substance of an entirely different chemical formula is excreted by the kidney. For example, sodium benzoate ingested and hippuric acid found in the urine.

Recently since transfusion has become so popular we have seen some very peculiar results from its use. The other day in the hospital a case of hemorrhage was transfused with blood from an incompatible donor, and in a few hours he got up a very marked hemoglobinuria. Much to my surprise when his blood was centrifugalized the serum was found to be clear. I supposed in cases of hemoglobinuria erythrolytic degeneration took place in the blood stream but apparently the corpuscles come to the kidney and are there broken down and the pigment liberated.

Dr. B. S. Barringer, New York: I should like to ask whether the kidney was lifted free from the body. If I remember rightly, there are in dogs vessels going into the cortex. Those might possibly contain nerves if not cut off.

Dr. Quinby (closing): I quite agree that there is a very definite selective action on the part of the kidney for some things, hemoglobin being one. My remembrance of the work of some other men in regard to this point is that in hemoglobinemia, such as that following an incompatible transfusion, the hemoglobin is almost immediately taken out of the blood stream by the liver, whence it goes much more slowly than it is produced to the kidney and is there secreted by active secretion on the part of the cells of the convoluted tubules.

In regard to Dr. Barringer's question, I should have made it clear that the kidneys were taken entirely out of the animals and laid on the table, although my picture did not show it.